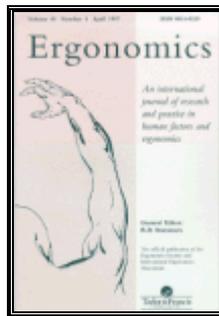


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Číslo 1 (January 2006)

Molen, Henk van der; Sluiter, Judith; Frings-Dresen, Monique. Is the use of ergonomic measures associated with behavioural change phases? S. 1-11(11).

Abstract: The aim of this study was to test the hypothesis that the absolute number of completed behavioural change phases (ABP) and the sequentially ordered number of completed behavioural change phases (SBP) are positively associated with the use of ergonomic measures by two groups of stakeholders in bricklaying companies (employers/planners, foremen/bricklayers). The measures, consisting of trestles, bricklaying scaffolds, mast-climbing work platforms and cranes, reduce the physical work demands made upon bricklayers and bricklayers' assistants. Structured interviews were conducted with stakeholders of 27 companies. Ordinal regression of behavioural change phases on the use of ergonomic measures showed a significant increase in both ABP and SBP in relation to increased use of three of the four ergonomic measures (i.e. trestles, bricklaying scaffolds, mast-climbing work platforms) by employers/planners and increased use of one ergonomic measure (i.e. trestles) by foremen/bricklayers. In conclusion, the positive and significant associations between the completed behavioural change phases (ABP and SBP) and use of ergonomic measures differ for the stakeholder groups and between the ergonomic measures. The data suggest that there is a higher chance of increasing the use of ergonomic measures by means of a higher ABP than a higher SBP. It is recommended for activities to be carried out—primarily by employers/planners—to facilitate as many behavioural change phases as possible in

order to stimulate actual use of ergonomic measures at worksites.

- **Keywords:** Behavioural change; Ergonomic measures; Implementation

Gold, Judith; Park, Jung-Soon; Punnett, Laura. Work routinization and implications for ergonomic exposure assessment. S. 12-27(16).

Abstract: Jobs in many modern settings, including manufacturing, service, agriculture and construction, are variable in their content and timing. This prompts the need for exposure assessment methods that do not assume regular work cycles. A scheme is presented for classifying levels of routinization to inform development of an appropriate exposure assessment strategy for a given occupational setting. Five levels of routinization have been defined based on the tasks of which the job is composed: 1) a single scheduled task with a regular work cycle; 2) multiple cyclical tasks; 3) a mix of cyclical and non-cyclical tasks; 4) one non-cyclical task; 5) multiple non-cyclical tasks. This classification, based primarily on job observation, is illustrated through data from a study of automobile manufacturing workers ($n = 1200$), from which self-assessed exposures to physical and psychosocial stressors were also obtained. In this cohort, decision latitude was greater with higher routinization level.

- **Keywords:** Observation; Checklist; Task-based analysis; Work-sampling; Work organization

Durkin, J.; Harvey, A.; Hughson, R.; Callaghan, J. The effects of lumbar massage on muscle fatigue, muscle oxygenation, low back discomfort, and driver performance during prolonged driving. S. 28-44(17).

Abstract: An increasing dependence of society on automobiles for both work and leisure and the corresponding increase in time spent seated in the car has been correlated with a greater risk of low back pain and absence from work (Porter and Gyi 2002). This study examined the effects of three types of lumbar massage units on seating comfort, muscle fatigue, muscle oxygenation, muscle blood flow and driving performance during a 1 h simulated driving task. Electromyographic (EMG) signals were recorded from the right and left thoracic and lumbar erector spinae musculature. Average EMG (AEMG), mean power frequency (MPF), gaps and amplitude probability distribution function (APDF) parameters were analysed from the three massage seats and compared to a control seat. Near infrared spectroscopy (NIRS) and skin temperature from the right thoracic and lumbar erector spinae were used as an indication of muscle oxygenation and blood flow throughout the driving task. Ratings of perceived discomfort were used to assess driver discomfort, and driving performance was assessed by calculating mean lap times for the duration of each driving trial. The results showed statistically significant increases in skin temperature compared with the control seat after 60 min of driving. The NIRS results reflected these trends although the results were not statistically significant. AEMG and MPF measures showed no significant differences between the seats. MPF measures were found to increase over time, effects attributed to increases in muscle temperature. Gaps and APDF analyses revealed greater rest times and lower activation levels, respectively, with the control seat, which could result in increased loading of passive structures. This study demonstrated the beneficial effects of lumbar massage systems in increasing muscle blood flow and oxygenation. Although EMG parameters were not significantly different, the trends support the significant blood flow results. Future research should include longer driving times and adjustments in EMG measures to account for the effects of increasing muscle temperature on AEMG and MPF measures.

- **Keywords:** Massage; Driving; Muscle fatigue; Discomfort; Spine

Dennerlein, Jack; Johnson, Peter. Different computer tasks affect the exposure of the upper extremity to biomechanical risk factors. S. 45-61(17).

Abstract: In order to determine differences in biomechanical risk factors across computer tasks, a repeated measures laboratory experiment was completed with 30 touch-typing adults (15 females and 15 males). The participants completed five different computer tasks: typing text, completing an html-based form with text fields, editing text within a document, sorting and resizing objects in a graphics task and browsing and navigating a series of intranet web pages. Electrogoniometers and inclinometers measured wrist and upper arm postures, surface electromyography measured muscle activity of four forearm muscles and three shoulder muscles and a force platform under the keyboard and force-sensing computer mouse measured applied forces. Keyboard-intensive tasks were associated with less neutral wrist postures, larger wrist velocities and accelerations and larger dynamic forearm muscle activity. Mouse-intensive tasks (graphics and intranet web page browsing) were associated with less neutral shoulder postures and less variability in forearm muscle activity. Tasks containing a mixture of mouse and keyboard use (form completion and text editing) were associated with higher shoulder muscle activity, larger range of motion and larger velocities and accelerations of the upper arm. Comparing different types of computer work demonstrates that mouse use is prevalent in most computer tasks and is associated with more constrained and non-neutral postures of the wrist and shoulder compared to keyboarding.

- **Keywords:** Office; Task analysis; Upper extremity; Computer

Bentley, Tim; Hide, Sophie; Tappin, David; Moore, Dave; Legg, Stephen; Ashby, Liz; Parker, Richard. Investigating risk factors for slips, trips and falls in New Zealand residential construction using incident-centred and incident-independent methods. S. 62-77(16).

Abstract: Slip, trip and fall (STF) incidents, particularly falls from a height, are a leading cause of injury in the New Zealand residential construction industry. The most common origins of falls from a height in this sector are ladders, scaffolding and roofs, while slipping is the most frequent fall initiating event category. The study aimed to provide detailed information on construction industry STF risk factors for high-risk tasks, work equipment and environments, as identified from an earlier analysis of STF claims data, together with information to be used in the development of interventions to reduce STF risk in New Zealand residential construction. The study involved the use of both incident-centred and incident-independent methods of investigation, including detailed follow-up investigations of incidents and observations and interviews with workers on construction sites, to provide data on a wide range of risk factors. A large number of risk factors for residential construction STFs were identified, including factors related to the work environment, tasks and the use and availability of appropriate height work equipment. The different methods of investigation produced complementary information on factors related to equipment design and work organization, which underlie some of the site conditions and work practices identified as key risk factors for residential construction STFs. A conceptual systems model of residential construction STF risk is presented.

- **Keywords:** Slips, trips and falls; Falls from a height; Residential construction; Injury investigations; Ladder falls

Dukic, T.; Hanson, L.; Falkmer, T. Effect of drivers' age and push button locations on visual time off road, steering wheel deviation and safety perception. S. 78-92(15).

Abstract: The study examined the effects of manual control locations on two groups of randomly selected young and old drivers in relation to visual time off road, steering wheel deviation and safety perception. Measures of visual time off road, steering wheel deviations and safety perception were performed with young and old drivers during real traffic. The results showed an effect of both driver's age and button location on the dependent variables. Older drivers spent longer visual time off road when pushing the

buttons and had larger steering wheel deviations. Moreover, the greater the eccentricity between the normal line of sight and the button locations, the longer the visual time off road and the larger the steering wheel deviations. No interaction effect between button location and age was found with regard to visual time off road. Button location had an effect on perceived safety: the further away from the normal line of sight the lower the rating.

- **Keywords:** Older drivers; Visual demand; Safety perception; Secondary task; Steering wheel deviation; Visual time off road; Younger drivers

Dempsey, Patrick; Filiaggi, Alfred. Cross-sectional investigation of task demands and musculoskeletal discomfort among restaurant wait staff. S. 93-106(14).

Abstract: A cross-sectional study of task demands and musculoskeletal discomfort among a sample of 100 wait staff in ten casual dining restaurants was conducted. In addition to answering a questionnaire about musculoskeletal discomfort and symptoms experienced in the past 12 months and attributed to work, subjects were asked about various aspects of their jobs, such as shift length, number of shifts per week and safety training. The managers of the restaurants were also interviewed to gather basic information on factors such as work hours, alternative duty availability and safety practices. When asked to rank the three most important causes of injuries, the responses of both managers and wait staff were congruent with Bureau of Labor Statistics (USA) data for 1999 on the nature of injuries and attributed exposures, with slips and falls, musculoskeletal disorders and acute injuries (e.g. burns, cuts) highlighted. Of the 100 subjects, 42% reported experiencing musculoskeletal symptoms in the past year, with the lower back area (18%) and shoulder (11%) with the most frequent symptoms reported in the responses. Although many of the materials handling tasks were not excessive, the heavier tray lifts and carries are a cause for concern. There are also slip and fall issues that influence the risks of these tasks. Future research needs, including addressing the mismatch between more common materials handling assessment tools and the nature of food serving tasks, are discussed.

- **Keywords:** Musculoskeletal discomfort; Restaurant; Slips and falls

✚ **Číslo 2 (February 2006)**

Heimburg, Erna von; Rasmussen, Anna Kari; Medbø, Jon. Physiological responses of firefighters and performance predictors during a simulated rescue of hospital patients. S. 111-126(16).

Abstract: There is incomplete information about how physically demanding rescue work may be. The aim therefore of this paper was to examine the physiological responses of firefighters during a simulated rescue of hospital patients and to relate the firefighters' performance to their endurance, strength and working technique. Fourteen part-time male firefighters with a maximal oxygen uptake (VO_{2max}) of 4.4 ± 0.3 l/min (mean \pm SD) served as subjects in this study. First, each firefighter ascended six floors (a 20.5 m vertical ascent) carrying tools, wearing protective clothing and a breathing apparatus, an extra mass of 37 kg. He thereafter 'rescued' six persons by dragging each person on a fire-sheet on a flat floor. The technique used was recorded and the O_2 uptake and the heart rate were measured continuously during the whole operation. The blood lactate concentration and the subjective rating of perceived exertion were measured during and just after the rescue. The VO_{2max} and the muscle strength were measured in the laboratory. The whole operation was carried out in the course of 5–9 min. The operation was a virtual all-out effort and the peak blood lactate concentration was 13 ± 3 mmol/l. The peak oxygen uptake was 3.7 ± 0.5 l/min (84% of the VO_{2max})

during the operation. Large and heavy firefighters carried out the task faster than smaller ones. The VO₂max in absolute terms and the dragging technique used were both related to the rescue performance. Rescuing patients at a hospital was physically very demanding and the time needed to complete the task depended on the VO₂max in absolute values and the working technique used. A minimum VO₂max of 4 l/min for firefighters was recommended.

- **Keywords:** Firefighting; Metabolism – oxygen consumption; Lactic acid – blood; Performance predictors

Motmans, R.; Tomlow, S.; Vissers, D. Trunk muscle activity in different modes of carrying schoolbags. S. 127-138(12).

Abstract: The daily load of carrying schoolbags is influenced by the mode of carriage. Electromyographic (EMG) activity from rectus abdominis and erector spinae was recorded bilaterally in five static conditions: no bag; shoulder bag; backpack; front pack; double pack. Nineteen students carried a load of 15% of their body weight. A double pack, with the load equally distributed in a front and a backpack, showed no significant differences in EMG activity compared with unloaded standing. The activity levels of erector spinae significantly decreased while carrying a backpack and increased with a shoulder bag and a front pack. Rectus abdominis revealed significantly higher EMG levels in the backpack trial. Asymmetrical activity between the right and the left part of the back muscles was clearly observed while carrying a shoulder bag with the weight at the right side of the body. The abdominal muscles revealed a slightly significant asymmetry for the shoulder bag and, surprisingly, also for the backpack. These findings suggest that the physical stresses associated with carrying book bags can be minimized by the design of a double pack. Asymmetry in muscle activity may indicate a failure of trunk stabilization and contribute to the development back pain.

- **Keywords:** EMG; Load carriage; Schoolbag; Backpack; Double pack

Delisle, Alain; Larivière, Christian; Plamondon, André; Imbeau, Daniel. Comparison of three computer office workstations offering forearm support: impact on upper limb posture and muscle activation. S. 139-160(22).

Abstract: The aims of the study were: 1) to determine whether resting the forearms on the work surface, as compared to chair armrests, reduces muscular activation; 2) to compare the sensitivity of different electromyographic (EMG) summary parameters. Eighteen healthy subjects performed computer work (with keyboard and mouse alternately) for 20 min while resting their forearms on a work surface adjustable in height (Workstation A), on the chair's armrests with an adjustable workstation (Workstation B) or on their chair's armrests with a non-adjustable workstation (Workstation C). The EMG amplitude of the trapezius and deltoid muscles was little influenced by the workstations, whereas their EMG variability increased with Workstation A, which was interpreted as a positive effect. However, the EMG amplitude of the mouse-side extensor digitorum muscle was higher with Workstation A. Alternating between resting the forearms on the work surface and on the chairs' armrests could solicit different muscles during computer work, and could be considered as a strategy for preventing musculoskeletal disorders. The new exposure variation analysis summary parameters used were sensitive to small workstation changes, thus supporting their use in future studies.

- **Keywords:** VDU; Workstation design; Musculoskeletal disorders; Forearm rest; EMG sensitivity

Walker, Guy; Stanton, Neville; Young, Mark. The ironies of vehicle feedback in car design. S. 161-179(19).

Abstract: Car drivers show an acute sensitivity towards vehicle feedback, with most normal drivers able to detect 'the difference in vehicle feel of a medium-size saloon car with and without a fairly heavy passenger in the rear seat' (Joy and Hartley 1953–54). The irony is that this level of sensitivity stands in contrast to the significant changes in vehicle 'feel' accompanying modern trends in automotive design, such as drive-by-wire and increased automation. The aim of this paper is to move the debate from the anecdotal to the scientific level. This is achieved by using the Brunel University driving simulator to replicate some of these trends and changes by presenting (or removing) different forms of non-visual vehicle feedback, and measuring resultant driver situational awareness (SA) using a probe-recall method. The findings confirm that vehicle feedback plays a key role in coupling the driver to the dynamics of their environment (Moray 2004), with the role of auditory feedback particularly prominent. As a contrast, drivers in the study also rated their self-perceived levels of SA and a concerning dissociation occurred between the two sets of results. Despite the large changes in vehicle feedback presented in the simulator, and the measured changes in SA, drivers appeared to have little self-awareness of these changes. Most worryingly, drivers demonstrated little awareness of diminished SA. The issues surrounding vehicle feedback are therefore similar to the classic problems and ironies studied in aviation and automation, and highlight the role that ergonomics can also play within the domain of contemporary vehicle design.

- **Keywords:** Feedback; Situational awareness; Signal detection theory; Vehicle design

Eksioglu, Mahmut. Optimal work–rest cycles for an isometric intermittent gripping task as a function of force, posture and grip span. S. 180-201(22).

Abstract: The aim of this study was to investigate the maximum acceptable contraction frequencies (i.e. work–rest cycles) for an isometric-intermittent handgrip task as a function of grip span, applied force and shoulder posture using psychophysical and physiological approaches. Twelve healthy males served as subjects. The three grip spans investigated were the optimal, 2 cm narrower than the optimal, and 2 cm wider than the optimal. The grip force levels studied were 15% and 30% of maximum voluntary grip force and the two shoulder postures were 25° flexion and 30° abduction. The psychophysical results indicate that subjects work faster with the narrower grip span at 15% of maximum voluntary grip force level in comparison to working with the optimal and the wider spans. However, when the task required 30% of maximum grip force level, the subjects worked faster with the optimal grip span. These findings were supported by the results of electromyography, heart rate, blood pressure and perceived discomfort. The study suggests that grip span of a tool is an important factor to be considered in predicting optimal work–rest cycles for hand grip tasks, and the optimum setting of grip span of the hand-tool depends on the required task force level. That is, the optimality is relative rather than absolute. In addition, it appears that weaker subjects can work at a higher rate than stronger ones at the same relative force level.

- **Keywords:** Work–rest cycle; Maximum acceptable frequency; Minimum acceptable rest time; Handgrip task; Grip span; Psychophysical approach

Trimmel, Michael; Poelzl, Gerhard Impact of background noise on reaction time and brain DC potential changes of VDT-based spatial attention. S. 202-208(7).

Abstract: Background noise is often discussed in terms of mental costs. In this study the effect of background noise on brain activity as reflected by the direct coupled (DC) potential was investigated by a within design in ten participants. During two successive blocks of 7 min each, participants performed 156 trials of a visual display terminal (VDT)-based visual-spatial attention task without noise and two blocks with a mixture of the environmental noises of barking dogs, traffic noise and irrelevant speech of 60 dBA. Brain

DC potentials were recorded along the midline and analysed for change by time on task. For noise conditions, reaction time was prolonged and the DC-potential shifted towards positivity, contrary to control condition, independent of block and location. Results suggest reduced cortical resources by widespread inhibitory activation through background noise. It can be concluded that even low intensity background noise is associated with energy consumption and with impaired performance in spatial attention.

- **Keywords:** Performance; Background noise; Brain DC potentials; Attention

Cadarette, Bruce; Chevront, Samuel; Kolka, Margaret; Stephenson, Lou; Montain, Scott; Sawka, Michael. Intermittent microclimate cooling during exercise-heat stress in US army chemical protective clothing. S. 209-219(11).

Abstract: The effectiveness of intermittent, microclimate cooling for men who worked in US Army chemical protective clothing (modified mission-oriented protective posture level 3; MOPP 3) was examined. The hypothesis was that intermittent cooling on a 2 min on-off schedule using a liquid cooling garment (LCG) covering 72% of the body surface area would reduce heat strain comparably to constant cooling. Four male subjects completed three experiments at 30°C, 30% relative humidity wearing the LCG under the MOPP 3 during 80 min of treadmill walking at $224 \pm 5 \text{ W} \cdot \text{m}^{-2}$. Water temperature to the LCG was held constant at 21°C. The experiments were; 1) constant cooling (CC); 2) intermittent cooling at 2-min intervals (IC); 3) no cooling (NC). Core temperature increased ($1.6 \pm 0.2^\circ\text{C}$) in NC, which was greater than IC ($0.5 \pm 0.2^\circ\text{C}$) and CC ($0.5 \pm 0.3^\circ\text{C}$).

- **Keywords:** Personal cooling; Heat strain; Chemical protective clothing; Human

🇺🇸 Číslo 3 (February 2006)

Shepherd, Gareth; Kahler, Roger; Cross, Jean. Ergonomic design interventions – a case study involving portable ladders. S. 221-234(14).

Abstract: Portable ladders are one of the most ancient tools conceived by man. They remain ubiquitous and indispensable even today. It is interesting to note that there is little difference between the makeshift portable ladders used throughout history and some still used today. The design of portable ladders seems to have simply evolved, rather than been subject to formal design process, including ergonomic criteria. An analysis of 277 fatalities associated with ladders was conducted to describe the pattern of ladder fatalities and identify and assess ergonomic design controls. All ladder fatalities analysed were found to contain multiple human, equipment (ladder) and environmental causative factors. It is hypothesized that significant gains with regard to reducing future fatalities can be achieved by applying ergonomic design principles to ladders to accommodate predictable and undesirable human behaviour. Without effective future change, the only prediction that can be made is that the pattern of ladder fatalities will simply continue.

- **Keywords:** Ladder; Taxonomy; Portable ladders

Lee, P.; Granata, K. Interface stability influences torso muscle recruitment and spinal load during pushing tasks. S. 235-248(14).

Abstract: Handle or interface design can influence torso muscle recruitment and spinal load during pushing tasks. The objective of the study was to provide insight into the role of interface stability with regard to torso muscle recruitment and biomechanical loads on the spine. Fourteen subjects generated voluntary isometric trunk flexion force against a

rigid interface and similar flexion exertions against an unstable interface, which simulated handle design in a cart pushing task. Normalized electromyographic (EMG) activity in the rectus abdominus, external oblique and internal oblique muscles increased with exertion effort. When using the unstable interface, EMG activity in the internal and external oblique muscle groups was greater than when using the rigid interface. Results agreed with trends from a biomechanical model implemented to predict the muscle activation necessary to generate isometric pushing forces and maintain spinal stability when using the two different interface designs. The co-contraction contributed to increased spinal load when using the unstable interface. It was concluded that handle or interface design and stability may influence spinal load and associated risk of musculoskeletal injury during manual materials tasks that involve pushing exertions.

- **Keywords:** Low-back; Stability; Co-contraction; Push-Pull; Handle interface

Oliver, Michele; Rogers, Robert; Rickards, Jeremy; Tingley, Maureen; Biden, Edmund. Effect of stiffness and movement speed on selected dynamic torque characteristics of hydraulic-actuation joystick controls for heavy vehicles. S. 249-268(20).

Abstract: The purpose of this work was to quantify the effects of joystick stiffness and movement speed on the dynamic torque characteristics of hydraulic-actuation joystick controls, as found in off-road vehicles, as one of the initial steps towards the development of a joystick design protocol. Using a previously developed mathematical model in which a hydraulic-actuation joystick is assumed to rotate about two axes where the rotation origin is a universal joint, the dynamic torque characteristics incurred by an operator were predicted. Utilizing a laboratory mock-up of an excavator cab environment, three actuation torque characteristics (peak torque, angular impulse and deceleration at the hard endpoint) were quantified for nine unskilled joystick operators during the use of a commonly used North American hydraulic-actuation joystick. The six different experimental conditions included combinations of three joystick stiffnesses and two movement speeds. The highest instantaneous input torque over the course of the joystick movement (not including the hard endpoint) was evaluated using the peak torque value. Angular impulse provided an indication of the sustained exposure to force. The third indicator, deceleration at the hard endpoint, was included to provide a description of impact loading on the hand as the joystick came to a sudden stop. The most important result of this work is that the dynamic torque characteristics incurred during hydraulic-actuation joystick use are substantial. While the peak torque values were not very different between the fast and slow motion conditions, the high decelerations even for slow movements observed at maximum excursion of the joystick indicate that the dynamics do matter. On the basis of deceleration at the hard endpoint and peak torque, the joystick movements that require the highest values for a combination of torque variables are the side-to-side ones. This suggests that less stiff balance and return springs should be considered for these directions than for forward and backward movements. However, if the design does not minimize acceleration, it is important that the spring stiffness not be too low since deceleration at the joystick hard endpoint will be very high causing the operator to incur large palm and finger impacts.

- **Keywords:** Dynamic forces; Hydraulic-actuation joysticks; Off-road machines

Doriot, Nathalie; Wang, Xuguang. Effects of age and gender on maximum voluntary range of motion of the upper body joints. S. 269-281(13).

Abstract: The maximum voluntary range of motion (ROM) of the major joints of the upper body was studied in a seated position and compared between young and elderly subjects. A total of 41 subjects (22 young male and female subjects aged 25 to 35 years, 19 elderly male and female subjects aged 65 to 80 years) took part in the experiment. In total, 13 maximum voluntary joint motions were performed by each subject. Age was

found to have a non-uniform effect on the ROM of the joints investigated in this study. Its effect on ROM was joint specific and motion specific. The highest loss in ROM was observed in the neck and trunk, especially for neck extension, lateral flexion and axial rotation as well as for trunk lateral flexion and axial rotation. No significant age differences were observed in the elbow and wrist joint ROMs. The effect of gender on joint ROM was much weaker than that of age. Only four among the 26 joint ROMs investigated in this study were significantly different between the two gender groups.

- **Keywords:** Range of motion; Upper body; Elderly; Sex; Reach

Cheng, P.; Dumas, G.; Smith, J.; Leger, A.; Plamondon, A.; McGrath, M.; Tranmer, J. Analysis of self-reported problematic tasks for pregnant women. S. 282-292(11).

Abstract: The objective of this study was to identify major components of, and influential factors in, problematic tasks performed by pregnant women employed in education, health care and service areas. Seventy-two pregnant women were surveyed using specially designed questionnaires consisting of an Initial Survey, a Job Analysis Questionnaire and a Task Description Questionnaire. Forty-four subjects (60%) had difficulty performing at least one work task and reported 105 tasks that were problematic at work. Reaching above the head, bending forward, bending and twisting, pushing, repeating actions and working at a fast pace were identified as the task components requiring the greatest level of effort. Excessive effort, excessive time, getting tired, repetitive actions, stress and fear of injury were identified as factors that had strong associations with the six major task components. Findings of this study suggest that these task components and factors should be considered when designing, assigning or analysing tasks for working pregnant women.

- **Keywords:** Pregnancy; Task analysis; Physical activities; Risk factor; Work design; Occupational

Barnett, Ralph; Liber, Theodore. Human push capability. S. 293-315(23).

Abstract: Use of unassisted human push capability arises from time to time in the areas of crowd and animal control, the security of locked doors, the integrity of railings, the removal of tree stumps and entrenched vehicles, the manoeuvring of furniture, and athletic pursuits such as US football or wrestling. Depending on the scenario, human push capability involves strength, weight, weight distribution, push angle, footwear/floor friction, and the friction between the upper body and the pushed object. Simple models are used to establish the relationships among these factors.

- **Keywords:** Push force; Leaning; Whole body push; Human push limit

Koppejan, S.; Snijders, C.; Kooiman, T.; Van Bommel, B. Hand and arm problems in flautists and a design for prevention. S. 316-322(7).

Abstract: Hand and arm problems are frequent in flautists. Severity is greatest in professional players, which can result in being unable to work. Based on a biomechanical analysis a support for the right hand was designed, which can be easily clipped on to the flute. Tests by professional flautists demonstrated that the right hand thumb support prevented rotation of the flute about its longitudinal axis. The latter reduces tension in forearm, wrist and fingers. This is the most important result of the study, which led to the introduction of the right hand thumb rest on the market.

- **Keywords:** Flute; Flautist; Biomechanics; Injuries; Ergonomics; Pain

✚ Číslo 4 (March 2006)

Moyer, B.; Chambers, A.; Redfern, M.; Cham, R. Gait parameters as predictors of slip severity in younger and older adults. S. 329-343(15).

Abstract: This study investigated the association between slip severity and pre-slip gait characteristics of younger and older subjects. Sixteen younger and eleven older healthy adults walked onto an unexpectedly slippery surface. Slip severity was categorized as either hazardous or non-hazardous using a 1.0 ms peak slip velocity threshold. The results showed that hazardous slips were associated with greater step lengths (normalized by leg length) (SLR), larger and more rapidly changing foot – floor angles (FFA) at heel strike, and increased cadence across the two subject groups. Older subjects were found to walk with shorter SLR and with smaller and more slowly changing FFA at heel strike compared to younger subjects. However, both younger and older subjects experienced hazardous slips at the same rate. A logistic regression model relating SLR and cadence to slip severity predicted that increased SLR and decreased cadence would result in increased probability of hazardous slip ($R^2 = 0.45$, $\chi^2 = 15.30$, p

- **Keywords:** Slips; Falls; Gait; Balance; Biomechanics; Ageing

Iridiastadi, H.; Nussbaum, M. Muscle fatigue and endurance during repetitive intermittent static efforts: development of prediction models. S. 344-360(17).

Abstract: Localized muscle fatigue has received growing attention as a potential design variable and exposure metric in research towards prevention of musculoskeletal disorders in the workplace. While fatigue during sustained static work has been investigated extensively, effects during tasks comprising work–rest cycles are less clear. Work–rest models for static intermittent work have been presented in several reports, but the applicability is often limited to specific conditions. A study was conducted that facilitated a description of the relationships between static intermittent efforts and muscle endurance and fatigue. Exercises consisted of 1 h (maximum) of repetitive static arm abductions, involving a range of muscle contraction levels (10–30% maximum voluntary exertion), duty cycles (0.2–0.8) and cycle times (20–180 s). A between-subject central composite experimental design was used and 15 different exercise conditions were examined with six participants (three females and three males) for each. Along with endurance times, temporal changes related to fatigue were monitored using muscle strength, ratings of discomfort and electromyography (EMG) obtained from the middle-deltoid muscle during the contraction phase of the work cycles. The results of this study showed the influence of contraction level and duty cycle on the majority of fatigue measures used, while cycle time tended to affect EMG spectral measures. Using a response surface methodology, several fatigue prediction models and contour plots were developed that can be employed as an aid for design and evaluation of light repetitive static tasks. Good correspondence was generally found between discomfort rating and other measures of fatigue, suggesting the usefulness of this measure for rapid assessments of local fatigue in the workplace.

- **Keywords:** Muscle fatigue; Endurance; Intermittent work; Electromyography; Perceived discomfort

Bao, S.; Spielholz, P.; Howard, N.; Silverstein, B. Quantifying repetitive hand activity for epidemiological research on musculoskeletal disorders – part I: individual exposure assessment. S. 361-380(20).

Abstract: An exposure measurement approach is described for quantifying repetitive hand activity of individual workers in a prospective epidemiological study on work-related

upper extremity musculoskeletal disorders. A total of 733 subjects were involved in this study at the baseline. Hand activities were quantified by force and repetition. Force levels were measured by workers' self-reports, ergonomists' estimates based on observation and measurements with instrumentation. Repetition levels were measured by detailed time-motion analyses using two repetitive hand activity definitions and ergonomists' estimates using scales for the American Conference of Governmental Industrial Hygienists hand activity level and the Strain Index. Results showed that the present exposure assessment approach seems to be able to quantify force level and repetitiveness of hand activities. Repetitive hand activity is quantified differently depending on whether forceful hand exertion or repetitive muscle activity is used as the definition. These hand activity definitions may quantify different physical exposure phenomena. Individual exposure assessment is important in epidemiological research of musculoskeletal disorders as there are interactions between the individual subjects and the measured parameters. These interactions may vary between exposure parameters.

- **Keywords:** Individual exposure quantification; Observational; Self-reporting; Direct measurement; Repetition; Hand force

Bao, S.; Howard, N.; Spielholz, P.; Silverstein, B. Quantifying repetitive hand activity for epidemiological research on musculoskeletal disorders – Part II: comparison of different methods of measuring force level and repetitiveness. S. 381-392(12).

Abstract: This paper focuses on comparisons between the different methods of assessing repetitive hand activities. Various methods were used to measure hand force and repetitiveness of hand activities on 733 subjects in the study described by Bao et al . (2006). Two definitions of repetitiveness were used in analysis of detailed time studies of repetitive hand activities and four parameters of the American Conference of Governmental Industrial Hygienists (ACGIH) hand activity level (HAL) and the Strain Index methods were estimated by ergonomists and used to quantify repetitiveness. Hand forces were measured or estimated using three different methods: 1) measured with a force gauge or mimicked on a force gauge (force matching); 2) estimated by ergonomists using rating scales; 3) self-reports by subjects. The jobs were also evaluated using the ACGIH HAL and Strain Index methods when different repetitiveness quantification methods were used. Results showed that different definitions of repetitive exertion might lead to measuring different physical exposure phenomena and produce very different results. There were poor correlations between the measures of repetitiveness estimated by the different methods. Correlations between force quantifications using different methods were also poor. This suggests that parameters measured by different methods might not be interchangeable. Both the ACGIH HAL and Strain Index methods identified more 'hazardous' jobs when repetitiveness was estimated by ergonomists than when it was calculated by detailed time studies of forceful hand exertions. The Strain Index method identified more 'hazardous' jobs than the ACGIH HAL method. Overall, the between-methods agreements were found to be moderate to substantial.

- **Keywords:** Exposure quantification; Repetition; Inter-method comparison; Hand force; Job evaluation

Patrick, J.; James, N.; Ahmed, A.; Halliday, P. Observational assessment of situation awareness, team differences and training implications. S. 393-417(25).

Abstract: The two goals were to investigate, first, the practicability and reliability of observational assessment of team situation awareness (SA) and, second, the nature of any team differences, their consistency and training implications. Five shift teams tackled three scenarios, each with three probe events concerning SA, and three observers viewed

and rated concurrently each shift. This methodology was found to be practicable and achieved satisfactory rater reliability as indicated by intraclass and inter-rater correlations. Team differences in SA emerged although there was no consistent pattern. A retrospective analysis of individual and team behaviours relating to SA was performed using the Critical Incident Technique. A total of 75 incidents and 20 behavioural dimensions relevant to SA were identified and these were subsumed under planning, problem solving, team coordination, attention, communication and knowledge. These findings are discussed with regard to the nature and measurement of SA, and the content of training to improve SA for control room teams.

- **Keywords:** Team situation awareness; Observational method; Rating reliability; Training

Selkirk, G.; McLellan, T.; Wong, J. The impact of various rehydration volumes for firefighters wearing protective clothing in warm environments. S. 418-433(16).

Abstract: This study examined different fluid replacement quantities during intermittent work while wearing firefighting protective clothing and self-contained breathing apparatus in the heat (35°C, 50% relative humidity). Twelve firefighters walked at 4.5 km per h with 0% elevation on an intermittent work (50 min) and rest (30 min) schedule until they reached a rectal temperature of 39.5°C during work periods and 40.0°C during rest, heart rates of 95% of maximum and/or exhaustion. During the heat-stress trials subjects received one of four fluid replacement quantities, high (H), moderate (M), low (L), and no hydration (NH), where H, M and L represented 78%, 63% and 37% of fluid loss, respectively. The total tolerance time (work + rest) was significantly greater during H (111.8 ± 3.5), M (112.9 ± 5.2) and L (104.2 ± 5.8) compared to NH (95.3 ± 3.8). In addition, work time (min), which excluded rest periods, was significantly greater in H (82.6 ± 3.5), and M (82.9 ± 5.2) compared to NH (65.3 ± 3.8). It is concluded that incorporating even partial fluid replacement strategies while wearing firefighting protective clothing and self-contained breathing apparatus in the heat improves tolerance time.

- **Keywords:** Uncompensable heat stress; Exercise tolerance; Rectal temperature; Metabolic rate; Fluid replacement

✚ **Číslo 5-6 (April – May 2006)**

Fogarty, G.; Mckeon, C. Patient safety during medication administration: The influence of organizational and individual variables on unsafe work practices and medication errors. S. 444-456(13).

Abstract: Medication errors are a leading cause of unintended harm to patients, both in Australia and internationally, and there is now a concerted attempt to identify and correct individual and workplace factors that encourage medication errors. The current study used structural equation modelling to measure organizational climate and to test a model with hypothesized links between climate and unsafe medication administration behaviours. The study also examined the possible mediating role of stress and morale. Data were collected from 176 nurses working in rural areas in Australia. The model provided a reasonable fit to the data with organizational climate accounting for 39% of the variance in individual distress, which in turn explained 7% of the variance in self-reported violations. The only variable that made a direct contribution to errors was violations, which accounted for 24% of the variance in medication errors. These findings highlight the importance of monitoring the state of the whole health system. Deficiencies at the organizational level affect the psychological well-being of hospital employees, and distressed employees are more likely to engage in substandard work practices that

ultimately endanger the patients under their care.

- **Keywords:** Medication errors; Patient safety; Systems approach

Elfering, A.; Semmer, N.; Grebner, S. Work stress and patient safety: Observer-rated work stressors as predictors of characteristics of safety-related events reported by young nurses. S. 457-469(13).

Abstract: This study investigates the link between workplace stress and the 'non-singularity' of patient safety-related incidents in the hospital setting. Over a period of 2 working weeks 23 young nurses from 19 hospitals in Switzerland documented 314 daily stressful events using a self-observation method (pocket diaries); 62 events were related to patient safety. Familiarity of safety-related events and probability of recurrence, as indicators of non-singularity, were the dependent variables in multilevel regression analyses. Predictor variables were both situational (self-reported situational control, safety compliance) and chronic variables (job stressors such as time pressure, or concentration demands and job control). Chronic work characteristics were rated by trained observers. The most frequent safety-related stressful events included incomplete or incorrect documentation (40.3%), medication errors (near misses 21%), delays in delivery of patient care (9.7%), and violent patients (9.7%). Familiarity of events and probability of recurrence were significantly predicted by chronic job stressors and low job control in multilevel regression analyses. Job stressors and low job control were shown to be risk factors for patient safety. The results suggest that job redesign to enhance job control and decrease job stressors may be an important intervention to increase patient safety.

- **Keywords:** Stress; Nurses; Safety; Stressful events; Job stressors; Job control

Carayon, P.; Hundt, A.; Alvarado, C.; Springman, S.; Ayoub, P. Patient safety in outpatient surgery : the viewpoint of the healthcare providers. S. 470-485(16).

Abstract: The objective of this study is to understand the viewpoint of healthcare providers with regard to patient safety in outpatient surgery settings. Two methods were used to gather data from the healthcare providers: (1) questionnaire with open-ended questions about six predefined stages of the patient care process; (2) survey with closed questions. With the first method, the main quality and safety of care issues concerned communication to patients, coordination of reports and forms, patient and staff time pressures and standards of care. The first two stages of the outpatient surgery process, i.e. patient work-up prior to day of surgery and patient admission and preparation on the day of surgery, yielded many more comments than the other four stages. The results of the structured questionnaire show that, overall, the healthcare providers report high quality of care provided by themselves (98%) and their surgery centre (96%). With regard to patient safety (i.e. cancellations of surgeries, patient safety problems and serious mistakes), there was a clear difference in perceptions reported by the physicians vs. the nurses and other staff. Nurses and other staff were more likely to report patient safety problems than physicians. The combination of qualitative data from the initial questionnaire and the quantitative data from the structured questionnaire provides a rather complete view of the outpatient surgery staff perceptions of quality and safety of care. This research highlights the importance of getting input from the healthcare providers regarding the quality and safety of care rather than relying only on traditional measures about patient outcomes.

- **Keywords:** Outpatient surgery; Healthcare providers; Quantitative and qualitative data; Patient safety

Kostopoulou, O. From cognition to the system: developing a multilevel taxonomy of patient safety in general practice. S. 486-502(17).

Abstract: The paper describes the process of developing a taxonomy of patient safety in general practice. The methodologies employed included fieldwork, task analysis and confidential reporting of patient-safety events in five West Midlands practices. Reported events were traced back to their root causes and contributing factors. The resulting taxonomy is based on a theoretical model of human cognition, includes multiple levels of classification to reflect the chain of causation and considers affective and physiological influences on performance. Events are classified at three levels. At level one, the information-processing model of cognition is used to classify errors. At level two, immediate causes are identified, internal and external to the individual. At level three, more remote causal factors are classified as either 'work organization' or 'technical' with subcategories. The properties of the taxonomy (validity, reliability, comprehensiveness) as well as its usability and acceptability remain to be tested with potential users.

- **Keywords:** Patient safety; Taxonomy; Human error; Information processing; Performance shaping factors; General practice

Kanse, L.; Van Der Schaaf, T.; Vrijland, N.; Van Mierlo, H. Error recovery in a hospital pharmacy. S. 503-516(14).

Abstract: A field study was performed in a hospital pharmacy aimed at identifying positive and negative influences on the process of detection of and further recovery from initial errors or other failures, thus avoiding negative consequences. Confidential reports and follow-up interviews provided data on 31 near-miss incidents involving such recovery processes. Analysis revealed that organizational culture with regard to following procedures needed reinforcement, that some procedures could be improved, that building in extra checks was worthwhile and that supporting unplanned recovery was essential for problems not covered by procedures. Guidance is given on how performance in recovery could be measured. A case is made for supporting recovery as an addition to prevention-based safety methods.

- **Keywords:** Error recovery; Near misses; Incident analysis; Medication error; Patient safety; Hospital pharmacy

Nyssen, A.; Blavier, A. Error detection: A study in anaesthesia. S. 517-525(9).

Abstract: Although error has been shown as the main cause of accidents in complex systems, little attention has been paid to error detection. However, reducing the consequences of error depends largely on error detection. The goal of this paper is to synthesize the existing scientific knowledge on error detection, mostly based on studies conducted in laboratory or self reporting and to further knowledge through the analysis of a corpus of cases collected in a complex system, anaesthesia. By doing this, this paper is better able to describe how this knowledge can be used to improve understanding of error detection modes. An anaesthesia accident reporting system developed and organized at two Belgian University Hospitals was used in order to collect information about the error detection patterns. Results show that detection of errors principally occurred through the standard check (routine monitoring of the environment). Significant relationships were found between the type of error and the error detection mode, and between the type of error and the training level of the anaesthetist who committed the error.

- **Keywords:** Human error; Error detection; Complex systems; Anaesthesia

Dieckmann, P.; Reddersen, S.; Wehner, T.; Rall, M. Prospective memory failures as an unexplored threat to patient safety: results from a pilot study using patient simulators to investigate the missed execution of intentions. S. 526-543(18).

Abstract: This study investigated failures of prospective memory (PM) as a relevant but neglected error type in medicine. A patient simulator was used to investigate PM failures. The influence of subjective importance (high, low) and type of intention (educational, internal, external) on the (missed) execution of intention was investigated in a 2 × 2 design. The effects on missed executions by importance (high 2 tests. Interaction was significant for missed executions ($p = 0.025$; $n = 19$; $df = 2$; $\chi^2 = 7.41$) and for executions ($p = 0.002$; $n = 54$; $df = 2$; $\chi^2 = 12.50$). Despite low statistical support and some methodological limitations, it was possible to show that PM failures are relevant to patient safety and that patient simulators are a suitable but so far unused tool for their investigation.

- **Keywords:** Prospective memory; Patient safety; Simulation; Human error

Hallock, M.; Alper, S.; Karsh, B. A macro-ergonomic work system analysis of the diagnostic testing process in an outpatient health care facility for process improvement and patient safety. S. 544-566(23).

Abstract: The diagnosis of illness is important for quality patient care and patient safety and is greatly aided by diagnostic testing. For diagnostic tests, such as pathology and radiology, to positively impact patient care, the tests must be processed and the physician and patient must be notified of the results in a timely fashion. There are many steps in the diagnostic testing process, from ordering to result dissemination, where the process can break down and therefore delay patient care and reduce patient safety. This study was carried out to examine the diagnostic testing process (i.e. from ordering to result notification) and used a macro-ergonomic work system analysis to uncover system design flaws that contributed to delayed physician and patient notification of results. The study was carried out in a large urban outpatient health-care facility made up of 30 outpatient clinics. Results indicated a number of variances that contributed to delays, the majority of which occurred across the boundaries of different systems and were related to poor or absent feedback structures. Recommendations for improvements are discussed.

- **Keywords:** Macro-ergonomics; Work system analysis; Diagnostic and laboratory testing; Patient safety

Catchpole, K.; Giddings, A.; de Leval, M.; Peek, G.; Godden, P.; Utle, M.; Gallivan, S.; Hirst, G.; Dale, T. Identification of systems failures in successful paediatric cardiac surgery. S. 567-588(22).

Abstract: Patient safety will benefit from an approach to human error that examines systemic causes, rather than blames individuals. This study describes a direct observation methodology, based on a threat and error model, prospectively to identify types and sources of systems failures in paediatric cardiac surgery. Of substantive interest were the range, frequency and types of failures that could be identified and whether minor failures could accumulate to form more serious events, as has been the case in other industries. Check lists, notes and video recordings were employed to observe 24 successful operations. A total of 366 failures were recorded. Coordination and communication problems, equipment problems, a relaxed safety culture, patient-related problems and perfusion-related problems were most frequent, with a smaller number of skill, knowledge and decision-making failures. Longer and more risky operations were likely to generate a greater number of minor failures than shorter and lower risk operations, and in seven higher-risk cases frequently occurring minor failures accumulated to threaten the safety of the patient. Non-technical errors were more prevalent than technical errors and task threats were the most prevalent systemic source of error. Adverse events in surgery are likely to be associated with a number of recurring and prospectively identifiable errors. These may be co-incident and cumulative human errors predisposed by threats embedded in the system, rather than due to individual

incompetence or negligence. Prospectively identifying and reducing these recurrent failures would lead to improved surgical standards and enhanced patient safety.

- **Keywords:** Error; Surgery; Observation; Health care; Safety

Healey, A.; Sevdalis, N.; Vincent, C. Measuring intra-operative interference from distraction and interruption observed in the operating theatre. S. 589-604(16).

Abstract: An observational tool was developed to record distraction and interruption in the operating theatre during surgery. Observed events were assigned to pre-defined categories and rated in relation to the level of team involvement – the sum of which was treated as a measure of intra-operative interference. Many events (0.29 ± 0.02 per min) were observed and rated in 50 general operations sampled from a single operating theatre. The rating of individual events ($r_s = 0.65$) and of cases ($r_s = 0.89$) correlated between independent observers. Interference levels ($1.04 \pm 0.07/\text{min}$) also correlated with door opening frequency ($0.68 \pm 0.03/\text{min}$).

- **Keywords:** Operating theatre; Surgery team; Distraction; Interruption; Performance; Safety

Hignett, S.; Masud, T. A review of environmental hazards associated with in-patient falls. S. 605-616(12).

Abstract: Slips, trips and falls present the greatest risk to in-patients in terms of exposure (frequency of occurrence) but only present a low severity risk in terms of mortality. The risk factors have been categorized as intrinsic (individual to the patient, e.g. visual impairment, balance problems and medicine use) or extrinsic (environmental). Many recommendations have been made concerning the management of environmental hazards but, of these, only beds rails have supporting research evidence. Other recommendations include patient assessment, footwear, flooring, lighting, staffing levels and bed alarms. However, three systematic reviews and the current narrative review have all failed to find research evaluating the benefits of these recommendations. The most robust evidence relates to the use of bed rails. This research suggests that bed rails not only fail to reduce the frequency of falls, but may also exacerbate the severity of injury. As Maslow's Hierarchy of Needs model has been used as a framework for nursing models of care, it was chosen as the basis for the development of an environmental hazard assessment model. The environmental hazards are revisited using this model in order to take an ergonomic or patient-centred approach for risk assessment.

- **Keywords:** Health-care ergonomics; Patient safety; Falls; User-centred design

Hellier, E.; Edworthy, J.; Derbyshire, N.; Costello, A. Considering the impact of medicine label design characteristics on patient safety. S. 617-630(14).

Abstract: Medication errors involving patients receiving the wrong medicines, the wrong dosages or failure to take medicines according to the prescribed schedule are a substantial threat to patient safety. In the medical domain, research evidence on the benefits of improved labelling are piecemeal and often single-product or single-manufacturer driven and often do not inform the more general process of label design. Government and other guidelines on this topic are often low level and non-specific, often failing to give evidence-based guidance. However, there is a wealth of evidence-based research findings in related areas such as food labelling, chemical labelling and more general warnings research, which can provide systematic evidence on the effects of design characteristics such as font size, colour, signal words and linguistic usage on crucial performance variables such as compliance, understandability and discriminability. This research is reviewed and its relevance to medicine labelling is presented.

- **Keywords:** Patient safety; Label design; Warning labels
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🚩 Číslo 7 (June 2006)

Boocock, M.; Weyman, A.; Mcilroy, R. Bedside safety rails: assessment of strength requirements and the appropriateness of current designs. S. 631-650(20).

Abstract: Bedside safety rails are used extensively throughout hospitals and residential care environments as a safety device to protect people against the risk of falling out of bed. However, several adverse incidents involving body entrapment have been linked to their use, which have resulted in serious injury to the bed occupants and, in more extreme cases, fatalities. Internationally agreed standards (i.e. European Committee for Standardisation (CEN) standards) for the design and testing of bed rails have recently been developed and are targeted at improved safety requirements (European Committee for Standardisation 19972000). The purpose of the present study was to: 1) determine whether the CEN test procedure for assessing bed rail strength and rigidity requirements is consistent with human force exertions to which bed rails may be exposed; 2) carry out loading tests on bed rails currently in use throughout the UK to determine whether they comply with the current safety recommendations proposed by the CEN standards. A laboratory study was conducted to determine the force exertions of 20 participants performing seven tasks (including activities of both bed occupants and care providers), which were considered representative of the forces to which bed rails could be exposed during normal use. Forces exerted by participants were measured using a force platform and distortions of the bed rails leading to potential entrapment zones were measured using linear displacement transducers. Static load tests were then conducted, in which incremental point loading was applied at the most adverse points on each of nine different bed rails (commonly used in UK nursing and residential care homes) in accordance with the test procedure detailed in the current CEN standards. Maximum static forces exerted by participants were found to range between 250 N and 350 N, which were within the 500 N force tolerance requirements set by the standards. Dynamic tasks involving 'rolling aggressively' against the bed rail produced the highest peak force of 722 N. None of the bed rails included in this study met the requirements of the CEN test procedures, principally due to horizontal lateral displacements being in excess of 50 mm for a 500 N applied force and/or the bed rails' inability to withstand inward horizontal forces of 500 N. Bed rails used with divan beds were often unable to withstand forces greater than 300 N due to turning moments exceeding the bed rail's restraining mechanism. Current CEN standards for assessing the strength and rigidity of bedside safety rails appear to be consistent with the human forces that might arise as a consequence of the normal movement and activities of a bed occupant or care provider. Although compliance with existing standards is not compulsory, findings from the tests carried out on the selection of bed rails in current use throughout the UK highlight the need for improvements in the design and manufacture of bed rails.

- **Keywords:** Bed rails; Bedside rails; Cot sides; Entrapment; Force exertions; Design specifications; Safety standards

Davies, S.; Mackinnon, S. The energetics of walking on sand and grass at various speeds. S. 651-660(10).

Abstract: This study investigated the energetics of walking on sand and grass. Fourteen adult males, participated in the study. Participants had a mean age of 34.6 years old, 72.6 kg in mass and 172.5 cm in stature, who walked at 3, 4, 5, 6 and 7 km per h on sand and grass surfaces. Physiological measures included heart rate, O₂ uptake, CO₂ exhalation, ventilation and relative O₂ uptake using a MetaMax Ergospirometer. Speed

was controlled in a methodology similar to the 'Multistage 20-m Shuttle Run Test'. Data were collected during physiological steady state at each determined speed. A minimum of 2 h rest was enforced between randomized conditions. Results indicate that there was a significant increase (p

- **Keywords:** Walking; Sand; Grass; Energetics; Compliance

Williams, A.; Rayson, M. Can simple anthropometric and physical performance tests track training-induced changes in maximal box-lifting ability? S. 661-670(10).

Abstract: The objective of this research was to determine if tests of lifting strength and anthropometry could be used to assess training-induced changes in box-lift performance. Ninety-two British Army recruits completed a 10-week training programme. Isometric and dynamic lifting strength, body composition and maximal box-lift to 1.45 m and 1.70 m were assessed before and after training. Training significantly increased box-lift performance, dynamic lifting strength and fat-free mass, and reduced body fat. Statistically significant regression models (adjusted R² of 0.299 and 0.152) were produced that predicted the changes in box-lift performance from changes in body composition and lifting strength. However, the 95% limits of agreement between the observed and predicted change in box-lift performance showed wide margins of error (11–13 kg; 26–29%). Training-induced changes in box-lift performance appear to be highly specific, which suggests that both training and testing procedures should also be specific to box-lift performance.

- **Keywords:** Military personnel; Physical conditioning; Material handling

Battevi, N.; Menoni, O.; Ricci, M.; Cairoli, S. MAPO index for risk assessment of patient manual handling in hospital wards: a validation study. S. 671-687(17).

Abstract: Manual handling of disabled patients – as regards movement – is one of the major factors affecting acute low back pain of exposed nursing staff. In the absence of quantitative methods assessing this kind of risk, the Research Unit Ergonomics of Posture and Movement of Milan developed in 1997 a risk assessment method called Movement and Assistance of Hospital Patients (MAPO), which is applicable in hospital wards. A first study conducted in 1999 allowed the identification of three levels of MAPO index corresponding with increasing probabilities of being affected by acute low back pain. In accordance with the well-known traffic light model, for MAPO index values between 0 and 1.5 the risk is considered to be absent or negligible. For values between 1.51 and 5.00 the risk is considered to be moderate. For values exceeding 5.00 the risk is considered to be high. In view of the limitations of the previous study, the results needed confirmation and so, in 2000–2001, another cross-sectional study was carried out, which included 191 hospital wards for acute and chronic patients and 2603 exposed subjects. This paper presents the analytical results of the association between the MAPO index and acute low back pain in this new data sample. The agreement between results of the two studies indicates that the MAPO index can be used as a risk index, although with some caution, as detailed in the paper. It can assess the risk exposure level of patient manual handling in wards and can be a useful tool for planning effective preventive actions to reduce the risk of work-related musculoskeletal disorders in health-care workers looking after disabled patients.

- **Keywords:** Manual lifting of patients; Handling patients; Low back pain; Exposure assessment; Nurses

Roth, E.; Scott, R.; Deutsch, S.; Kuper, S.; Schmidt, V.; Stilson, M.; Wampler, J. Evolvable work-centred support systems for command and control: creating systems users can adapt to meet changing demands. S. 688-705(18).

Abstract: Military command and control (C2) organizations are complex socio-technical systems which must constantly adapt to meet changing operational requirements. We describe our experiences in developing a work-centred support system (WCSS) to aid weather forecasting and monitoring in a military airlift C2 organization as an illustrative case. As part of the development process we conducted field observations both before and after introduction of the WCSS in their operations centre. A striking finding was the constant changes that operations personnel faced (changes in goals and priorities, changes in scale of operations, changes in team roles and structure, and changes in information sources and systems). We describe the changes in workplace demands that we observed and the modifications we needed to make to the WCSS in response. For today's fielded systems, it is seldom possible to make changes that are responsive to users' changing requirements in a timely manner. We argue for the need to incorporate facilities that enable users to adapt their systems to the changing requirements of work and point to some promising directions towards evolvable work-centred support systems.

- **Keywords:** Work-centred support systems; Evolvable systems; End-user development; C2; Weather forecasting; Work-centred design

Bos, E.; Krol, B.; Van Der Star, A.; Groothoff, J. The effects of occupational interventions on reduction of musculoskeletal symptoms in the nursing profession. S. 706-723(18).

Abstract: The objective of the review was to gain more insight into the effects of occupational interventions for primary prevention of musculoskeletal symptoms in healthcare workers. The Cochrane Collaboration methodological guidelines for systematic reviews functioned as a starting point. Thirteen studies meeting the inclusion criteria were analysed for methodological quality and effects. Eight outcome effect areas were established and defined as areas in which an effect had been determined in at least two studies. A method based on levels of scientific evidence was then used to synthesize the information available. Strong scientific evidence for the beneficial effect of occupational interventions was found for the outcome effect areas physical discomfort, technical performance of transfers and frequency of manual lifting. Insufficient evidence was found for the effect areas absenteeism due to musculoskeletal problems, musculoskeletal symptoms, fatigue, perceived physical load and knowledge of risk factors at work and ergonomic principles. Training and education combined with an ergonomic intervention were found to be effective.

- **Keywords:** Programme evaluation; Primary prevention; Occupational health; Review literature; Health care

Ho, Cristy; Tan, Hong; Spence, Charles. The differential effect of vibrotactile and auditory cues on visual spatial attention. S. 724-738(15).

Abstract: Previous research has shown that the presentation of spatially predictive auditory and vibrotactile warning signals can facilitate driver responses to driving events seen through the windscreen or rearview mirror. The present study investigated whether this facilitation reflects the priming of the appropriate response (i.e. braking vs. accelerating) or an attentional cuing effect (i.e. a perceptual benefit that facilitates subsequent behavioural responding). In the experiments reported here, participants had to discriminate the colour of a number plate (red vs. blue) following the presentation of either spatially predictive vibrotactile (experiment 1) or auditory (experiment 2) warning signals that indicated the likely location (front or back) of the visual target, while simultaneously performing a highly attention-demanding rapid serial visual presentation task. Numberplate discrimination performance was facilitated following the presentation of valid auditory cues, but not following the presentation of equally informative vibrotactile cues. The use of an orthogonal spatial cuing design enabled with us to rule out of a potential response priming account of these data. The results suggest that whilst

directional congruency between a warning signal and a target event may be sufficient to facilitate performance due to the priming of the appropriate response, attentional facilitation effects may also require the co-location of the cue and target within the same functional region of space.

- **Keywords:** Warning signal; Driving; Crossmodal spatial attention; Auditory; Vibrotactile; Visual
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Číslo 8 (June 2006)

The History of the Ergonomics Society. S. 741-742(2).

Waterson, Patrick; Sell, Reg. Recurrent themes and developments in the history of the Ergonomics Society. S. 743-799(57).

Abstract: This paper provides an outline of the main historical developments and recurrent themes that have taken place in the history of the Ergonomics Society (ES) over 50 years. Alongside a chronology of significant events during the period 1949-1999, a set of issues raised by interviews with prominent members of the ES and other historical materials, we focus specifically on seven main areas: the growth and influence of the ES (e.g. internationalization, membership changes); external relations (e.g. press and public relations); publications (e.g. Society journals and key texts); key individuals and institutions; influence on government and other bodies (e.g. participation in committees and inquiries); and image and identity (e.g. changes to the image of the ES over time). We conclude the paper with a summary and discussion of the key developments in the history, as well as the outstanding challenges for the future.

- **Keywords:** Ergonomics history; UK Ergonomics Society history
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Číslo 9 (July 2006)

Boocock, M.; Haslam, R.; Lemon, P.; Thorpe, S. Initial force and postural adaptations when pushing and pulling on floor surfaces with good and reduced resistance to slipping. S. 801-821(21).

Abstract: The objective of the present study was to determine whether differences in the frictional properties of a floor surface may affect the kinematics and kinetics of pushing and pulling. Eight male participants were required to push and pull a four-wheeled trolley over two level surfaces, on which were mounted floor coverings with good (safety floor) and reduced (standard floor) frictional properties. A psychophysical approach was used to determine the initial maximum acceptable horizontal force required to move the trolley over a short distance (3 m). Three-dimensional (3D) hand and ground reaction forces and 3D postures were measured during initial force exertions. The results showed that psychophysically derived measures of initial horizontal force and horizontal components of hand forces did not differ significantly between floor surfaces. Despite the ability to exert similar forces, the measured maximum coefficient of friction varied according to floor surface. These changes reflected significant alterations in vertical and horizontal components of ground reaction and vertical hand forces, suggesting that participants had maximized the frictional properties available to them. Postures also changed as a consequence of floor surface, with significant changes occurring in knee flexion and trunk extension. This study has shown that handlers involved in the pushing and pulling of trolleys are capable of adjusting posture and the direction of hand and foot forces in order to compensate for reduced levels of floor

friction. This has particular relevance when assessing the musculoskeletal loads imposed on the handler and the likely mechanisms of injury resulting from variations in floor conditions when workers undertake pushing and pulling tasks in the workplace.

- **Keywords:** Biomechanics; Ergonomics; Pushing and pulling; Slipping; Manual handling; Psychophysics

Meijer, Eline; Formanoy, Margriet; Visser, Bart; Sluiter, Judith; Frings-Dresen, Monique. Effects of a thermal-insulating mouse pad on temperature of forearm and hand during computer tasks. S. 822-831(10).

Abstract: This laboratory experiment studied the effects of a thermal-insulating mouse pad on arm temperature and comfort during computer work. Fourteen subjects performed two 20-min computer tasks (a mouse task and a combined task alternating keyboard and mouse use), under three conditions, namely with: 1) a thermal-insulating pad; 2) a placebo pad; 3) no pad (desktop). The temperatures of the forearm, wrist, hand and fingers were measured with four thermocouples. Comfort and discomfort were determined by two visual analogue scales. No arm temperature differences were found between the experimental conditions after performing the combination task in any location. After the mouse task, however, arm temperature decreased significantly less with the thermal-insulating mouse pad than with the placebo pad. The thermal-insulating pad was rated as more comfortable and less uncomfortable than a regular desktop during mouse tasks. A large size is recommended for the thermal-insulating pad.

- **Keywords:** Ergonomic intervention; Skin temperature; Work-related upper extremity musculoskeletal disorder; Prevention; Computer task; VDU work

Ward, Nicholas; Shankwitz, Craig; Gorgestani, Alec; Donath, Max; de Waard, Dick; Boer, Erwin. An evaluation of a lane support system for bus rapid transit on narrow shoulders and the relation to bus driver mental workload. S. 832-859(28).

Abstract: The use of dedicated bus shoulders is a key method for implementing bus rapid transit (BRT) in areas that do not have the space for additional infrastructure. However, the narrow width of the bus shoulder and the need to anticipate traffic hazards in the adjacent lane can both be significant stressors for bus drivers. Bus driver mental workload and stress in response to these conditions should be a significant concern both for operational safety and driver health. This pilot study evaluated the potential stressors of traffic density and shoulder width in the context of an express BRT service in a large US metropolitan area. In addition, the study considered the potential role of a prototype lane support system (LSS) to support vehicle control within the narrow shoulder boundaries. Ten experienced bus drivers drove an actual route with an instrumented bus equipped with and without LSS. Self-reported effort was recorded along with performance measures of speed and position control relevant to mobility and safety objectives. Bus drivers did note stressors in the BRT environment and the prototype LSS. However, the use of the shoulder during high-density traffic conditions did improve mobility. Moreover, the LSS did enhance safety on the shoulder when there was high-density traffic in the adjacent lane. However, there was no evidence that the LSS reduced bus driver workload while operating in the narrow shoulder. Future research should consider the impact of BRT operations and support systems on bus driver mental workload and stress, and support the deployment of such devices for bus operations on shoulders during high traffic volumes.

- **Keywords:** Bus rapid transit; Driver workload; Lane support; Driving stressors

Wong, T.; Chow, D.; Holmes, A.; Cheung, K. The feasibility of repositioning ability as a tool for ergonomic evaluation: effects of chair back inclination and

fatigue on head repositioning. S. 860-873(14).

Abstract: Poor posture has been suggested as one of the main factors contributing to the high prevalence of neck pain in video display unit (VDU) users, but no clear association between pain and any particular resting neck posture has been found. Postural awareness of the neck, as indicated by the repositioning accuracy, may therefore be an appropriate measure and potentially useful assessment tool. The objective of this study is to examine whether posture and fatigue affect the head repositioning ability in typical VDU usage. A group of 20 healthy participants reproduced a normal comfortable posture for forward, upright and backward chair back inclinations in random order both before and after fatigue of the upper trapezius muscles. Ten repetitions of the posture were recorded for 2 s each, and the angular and translational deviations from the original head position were measured with regard to the external environment (head in space repositioning) and with regard to the trunk (head on trunk repositioning). Analysis by repeated measures ANOVA showed significant effects and interactions of fatigue and chair back inclination on the repositioning errors in the sagittal plane, which typically showed systematic trends towards certain postures rather than random errors around a mean position. While further work is required to examine the ergonomic impact of impaired repositioning ability, head repositioning is sensitive to ergonomic factors such as seating configuration and fatigue, and may therefore be a useful tool for evaluation of static working postures.

- **Keywords:** Biomechanics; Head repositioning; Backrest inclination; Fatigue

Sharma, S. Linear temporal characteristics of heart interbeat interval as an index of the pilot's perceived risk. S. 874-884(11).

Abstract:

The concept of adaptive automation is the first commendable step towards machine monitoring and support of the human operator behaviour and performance. Despite a large number of studies, the concept is still not sufficiently mature and more experimental studies are required to enable its application in the real world. As a small contribution in this direction, this experimental study made an effort to develop some techniques for online assessment of the pilot's perceived risk of the consequences resulting from their inability to execute a task adequately. Linear dynamical characteristics of 60 pilot's heart interbeat intervals were used for the assessment. Past research has shown that such 'perceived risk' influences the pilot's need for an automation aid. The preliminary results of this study suggested that the frequency and power of the heart interbeat interval dominant cycle, together with the characteristics of the energy contained in the power spectrum, can be sensitive indices of the level of perceived risk. The study techniques and preliminary results appear promising for incorporation into the algorithm of an intelligent online monitoring and alerting system on future aerospace vehicles to define the moments when the human supervisory controllers require an automation aid.

- **Keywords:** Power spectrum; Heart interbeat interval; Human-machine system; Linear dynamics

Fiolkowski, Paul; Horodyski, Marybeth; Bishop, Mark; Williams, Melissa; Stylianou, Lee. Changes in gait kinematics and posture with the use of a front pack. S. 885-894(10).

Abstract: The objective of this study was to determine if posture during gait can be affected by position of the load. It was hypothesized that the front pack would result in postural changes in the gait cycle, compared to a similarly loaded backpack. Thirteen healthy adults, free of any injury, volunteered to participate in this study. Two

dimensional video data were collected at 50 Hz using a MacReflex video system. A backpack and a front pack were compared using loads of 10 and 15% of body weight. Markers were placed on the ear, acromion, greater trochanter and lateral joint line of the knee, lateral malleolus and fifth metatarsophalangeal joint. Data were collected while the participants walked at 0.75 stride/s. The data were used to calculate joint angles and displacements during each gait cycle. There was a significant difference noted in angles of the hip flexion, with the backpack condition demonstrating a greater flexion in each stride than either the control or front pack. Both backpack and front pack conditions demonstrated a significant change in neck motion compared to the control condition. The results of the position analysis over time also revealed an increase in the forward head position when participants were wearing the backpack compared to either the control or the front pack condition. It was concluded that the use of a front pack results in a more upright posture in gait, when compared to a backpack carrying the same load.

- **Keywords:** Kinematics; Gait; Carriage; Backpack

Lett, Kelly; McGill, Stuart. Pushing and pulling: personal mechanics influence spine loads. S. 895-908(14).

Abstract: This study assessed several mechanical issues related to low back loading during pushing and/or pulling tasks. Nine male participants performed two-handed pushing and pulling tasks at two handle heights with three loads, using a cable pulley system. Four of these men were professional firefighters trained in performing pushing and pulling tasks while the other five were graduate students who lacked manual work experience. The more experienced firefighters produced less spinal compression and shearing forces when compared to the less experienced students under the same conditions. The firefighters were able to create less muscle activation as compared to the students, which indicated a more efficient technique. The main contributing factors to the forces produced on the low back were the quantity of the load being pushed or pulled, handle height, experience level and the technique of the participant. Thus, attempts to set load limits for pushing and pulling tasks are difficult, since technique has such a large influence on back loading. In order to create safer working environments, education on proper pushing and pulling techniques is very important - more important than the physical variables in many cases.

- **Keywords:** Push; Pull; Low back

Číslo 10 (August 2006)

Dreger, Randy; Jones, Richard; Petersen, Stewart. Effects of the self-contained breathing apparatus and fire protective clothing on maximal oxygen uptake. S. 911-920(10).

Abstract: To examine the effects of firefighting personal protective ensemble (PPE) and self-contained breathing apparatus (SCBA) on exercise performance, 12 males completed two randomly ordered, graded exercise treadmill tests (GXT PPE and GXT PT). Maximal oxygen consumption ($\dot{V}O_{2max}$) during GXT PPE was 17.3% lower than the GXT PT in regular exercise clothing (43.0 ± 5.7 vs. 52.4 ± 8.5 ml/kg per min, respectively). The lower $\dot{V}O_{2max}$ during the PPE condition was significantly related.

- **Keywords:** Firefighting; Personal protective equipment; $\dot{V}O_{2max}$ test; Tidal volume; Gas exchange; Self-contained breathing apparatus

Madeleine, Pascal; Vedsted, Pernille; Blangsted, Anne; Sjøgaard, Gisela; Sjøgaard, Karen Effects of electromyographic and mechanomyographic

biofeedback on upper trapezius muscle activity during standardized computer work. S. 921-933(13).

Abstract: The purpose of this laboratory study was to investigate the effects of surface electromyography (EMG)- and mechanomyography (MMG)-based audio and visual biofeedback during computer work. Standardized computer work was performed for 3 min with/without time constraint and biofeedback in a randomized order. Biofeedback was given on the basis of an individual preset threshold value for the right trapezius EMG and MMG signal and a time factor (repetition of events above the threshold). The duration of muscle activity above the preset threshold, the right trapezius EMG and MMG root mean square (RMS) values as well as the work performance in terms of number of completed graph/mouse clicks/errors, the rating of perceived exertion (RPE) and the usefulness of the biofeedback were assessed. The duration of muscle activity above the threshold was significantly lower with MMG compared with EMG as source of biofeedback.

- **Keywords:** Feedback; Electromyography; Mechanomyography; Neck-shoulder region

Sauer, Jürgen; Felsing, Tobias; Franke, Holger; Rüttinger, Bruno. Cognitive diversity and team performance in a complex multiple task environment. S. 934-954(21).

Abstract: This article examines the multiple effects of cognitive diversity in teams operating complex human-machine-systems. The study employed a PC-based multiple-task environment, called the Cabin Air Management System, which models a process control task in the operational context of a spacecraft's life support system. Two types of cognitive diversity were examined: system understanding and team specialization. System understanding referred to the depth of understanding team members were given during training (low-level procedure-oriented vs. high level knowledge-oriented training). Team specialization referred to the degree to which knowledge about system fault scenarios was distributed between team members (specialized vs. non-specialized). A total of 72 participants took part in the study. After having received 4.5 h of training on an individual basis, participants completed a 1-h experimental session, in which they worked in two-person teams on a series of fault scenarios of varying difficulty. Measures were taken of primary and secondary task performance, system intervention and information sampling strategies, system knowledge, subjective operator state, communication patterns and conflict. The results provided evidence for the benefits of cognitive diversity with regard to system understanding. This manifested itself in better primary task performance and more efficient manual system control. No advantages were found for cognitive diversity with regard to specialization. There was no effect of cognitive diversity on intra-team conflict, with conflict levels generally being very low. The article concludes with a discussion of the implications of the findings for the engineering of cognitive diversity in teams operating complex human-machine-systems.

- **Keywords:** Team performance; Team diversity; Training; Conflict; Team heterogeneity

Wade, Chip; Davis, Jerry; Marzilli, Thomas; Weimar, Wendi. Information processing capacity while wearing personal protective eyewear. S. 955-967(13).

Abstract: It is difficult to overemphasize the function vision plays in information processing, specifically in maintaining postural control. Vision appears to be an immediate, effortless event; suggesting that eyes need only to be open to employ the visual information provided by the environment. This study is focused on investigating the effect of Occupational Safety and Health Administration regulated personal protective eyewear (29 CFR 1910.133) on physiological and cognitive factors associated with

information processing capabilities. Twenty-one college students between the ages of 19 and 25 years were randomly tested in each of three eyewear conditions (control, new and artificially aged) on an inclined and horizontal support surface for auditory and visual stimulus reaction time. Data collection trials consisted of 50 randomly selected (25 auditory, 25 visual) stimuli over a 10-min surface-eyewear condition trial. Auditory stimulus reaction time was significantly affected by the surface by eyewear.

- **Keywords:** Personal protective eyewear; Personal protective equipment; Selective attention; Information processing; Reaction time

Gregory, Diane; Milosavljevic, Stephan; Callaghan, Jack. Quantifying low back peak and cumulative loads in open and senior sheep shearers in New Zealand: Examining the effects of a trunk harness. S. 968-981(14).

Abstract: Sheep shearing requires shearers to adopt sustained flexed postures for prolonged periods of time and has been associated with an increased risk of developing low back pain (LBP). However, these postures do not generally result in acute compressive values at L4/L5 exceeding the action limit proposed by the National Institute for Occupational Safety and Health, despite the high prevalence of LBP in this occupation. Therefore, it may not be peak loading that is responsible for LBP in this occupation but instead it may be the effect of cumulative loading over the course of a workday. The primary purpose of this research was to quantify the low back cumulative load exposure in 12 sheep shearers with and without the aid of a commercial trunk harness. Results revealed a significant reduction in the magnitude of cumulative compression with the use of the trunk harness and therefore its use may potentially reduce the risk of injury. The use of the trunk harness also reduced the time spent in axially twisted postures, which have been associated with LBP. However, using the trunk harness also resulted in increased time spent in laterally bent postures, which has been associated with increased risk for pain and injury.

- **Keywords:** Cumulative loading; Low back pain; Sheep shearing; Force weighting

Burnfield, J.; Powers, C. Prediction of slips: an evaluation of utilized coefficient of friction and available slip. Resistance. S. 982-995(14).

Abstract: The purpose of this study was to investigate the relationship between measures of floor surface slip resistance and an individual's peak utilized coefficient of friction (COF U) on the probability of a slip occurring during level walking. Video, kinematic and ground reaction force data were recorded simultaneously as subjects walked at a self-selected speed during conditions of normal and reduced floor surface slip resistance. Peak COF U during weight acceptance was calculated and the available floor surface slip resistance was measured using the variable incidence tribometer (VIT). Separate logistic regression analyses identified that knowledge of the available slip resistance (as measured by the VIT) in combination with an individual's peak COF U allowed for greater accuracy in classifying slip outcomes (89.5%; $p = 0.004$), while knowledge of only the available slip resistance reduced the accuracy of categorization to 78.9% ($p = 0.021$).

- **Keywords:** Slip resistance; Coefficient of friction; Slips and falls; Walking; Tribometer

Buften, Marcia; Marklin, Richard; Nagurka, Mark; Simoneau, Guy Effect of keyswitch design of desktop and notebook keyboards related to key stiffness and typing force. S. 996-1012(17).

Abstract: This study aimed to compare and analyse rubber-dome desktop, spring-column desktop and notebook keyboards in terms of key stiffness and fingertip typing

force. The spring-column keyboard resulted in the highest mean peak contact force (0.86N), followed by the rubber dome desktop (0.68N) and the notebook (0.59N). All these differences were statistically significant. Likewise, the spring-column keyboard registered the highest fingertip typing force and the notebook keyboard the lowest. A comparison of forces showed the notebook (rubber dome) keyboard had the highest fingertip-to-peak contact force ratio (overstrike force), and the spring-column generated the least excess force (as a ratio of peak contact force). The results of this study could aid in optimizing computer key design that could possibly reduce subject discomfort and fatigue.

- **Keywords:** Computer keys; Computer keyboard; Typing; Typing force

Grouios, George. Right hand advantage in visually guided reaching and aiming movements: brief review and comments. S. 1013-1017(5).

Abstract: Although understanding of the organization and control of visually guided reaching and aiming movements is still sketchy and incomplete, evidence from behavioural studies supports the contention that right-handed individuals typically execute aiming movements with better speed, smoothness and consistency, and with a greater degree of spatial precision when performing them with their right hand. Creative attempts to account for the superiority of the right hand on a variety of visually guided reaching and aiming tasks have focused on the processing characteristics of the contralateral or left cerebral hemisphere. This brief review summarizes the research conducted over the last few decades on the subject, highlights the theoretical interpretations offered to explain manual asymmetries in the organization and control of goal-directed movements and identifies directions for further empirical research. The theoretical and practical implications of laterality research efforts along the lines of goal-directed behaviour are discussed.

- **Keywords:** Visually-guided reaching and aiming movements; Manual asymmetry; Right hand; Left hemisphere; Cerebral mechanisms

 **Číslo 11 (September 2006)**

Huysmans, Maaïke; de Looze, Michiel; Hoozemans, Marco; van der Beek, Allard; van Dieën, Jaap. The effect of joystick handle size and gain at two levels of required precision on performance and physical load on crane operators. S. 1021-1035(15).

Abstract: The study was designed to determine the effect of joystick handle size and (display-control) gain at two levels of required task precision on performance and physical load on crane operators. Eight experienced crane operators performed a simulated crane operation task on a computer by use of a joystick with either a short or a large handle. The task was performed at three gain levels and at two levels of required precision. Task performance, wrist and forearm postures, upper extremity muscle activity, perceived exertion and perceived comfort were measured. Task performance improved when using the joystick with the short handle and when working at a higher gain, while physical load decreased or remained the same. An increased level of required task precision was associated with a lower performance, but physical load was not affected. External validity of the simulated crane task seemed sufficient enough to extrapolate the results to practice. A joystick with a short handle is recommended, as this leads to an increased performance whilst the operator's physical load decreases or remains the same. Further optimization of performance and physical load can be achieved by optimizing gain settings of the joystick in relation to the task and type of joystick used.

- **Keywords:** Joystick operation; Gain; Precision; Performance; Kinematics; Electromyography

Dickerson, Clark; Martin, Bernard; Chaffin, Don. The relationship between shoulder torques and the perception of muscular effort in loaded reaches. S. 1036-1051(16).

Abstract: The objective of this study was to define the quantitative relationship between external dynamic shoulder torques and calibrated perceived muscular effort levels for load delivery tasks, for application in job analyses. Subjects performed a series of loaded reaches and, following each exertion, rated their perceived shoulder muscular effort. Motion and task physical requirements data were processed with a biomechanical upper extremity model to calculate external dynamic shoulder torques. Calculated torque values were then statistically compared to reported calibrated perceived muscular effort scores. Individual subject torque profiles were significantly positively correlated with perceived effort scores ($r^2 = 0.45-0.77$), with good population agreement ($r^2 = 0.50$). The accuracy of the general regression model improved ($r^2 = 0.72$) with inclusion of factors specific to task geometry and individual subjects. This suggests two major conclusions: 1) that the perception of muscular shoulder effort integrates several factors and this interplay should be considered when evaluating tasks for their impact on the shoulder region; 2) the torque/perception relationship may be usefully leveraged in job design and analysis.

- **Keywords:** Shoulder; Biomechanics; Muscular effort perception; Psychophysics

Arvidsson, I.; Arvidsson, M.; Axmon, A.; Hansson, G.; Johansson, C.; Skerfving, S. Musculoskeletal disorders among female and male air traffic controllers performing identical and demanding computer work. S. 1052-1067(16).

Abstract: Operators with identical, demanding computer work (90 female and 97 male air traffic controllers) were found to have high prevalences of disorders (assessed by questionnaire and physical examination) in neck, shoulders and upper back. In spite of the identical work, the women displayed higher prevalences than the men (e.g. neck diagnoses 21% vs. 4%). Disorders in elbows, wrists and hands were less common, with similar rates in both genders. Generally, the psychosocial work environment (assessed by questionnaire) was found to be good, but with large inter-individual variation. Women experienced lower decision latitude than men, particularly regarding influence and freedom at work, but perceived higher social support. Physically, the work was characterized by relatively low angular velocities of upper arms (measured by inclinometry) and wrists (right:

- **Keywords:** Physical examination; Complaints; Diagnoses; Neck; Psychosocial work environment; Physical exposure

Venetjoki, N.; Kaarlela-Tuomaala, A.; Keskinen, E.; Hongisto, V. The effect of speech and speech intelligibility on task performance. S. 1068-1091(24).

Abstract: The aim of this study was to find out what are the effects of three different sound environments on performance of cognitive tasks of varying complexity. These three sound environments were 'speech', 'masked speech' and 'continuous noise'. They corresponded to poor, acceptable and perfect acoustical privacy in an open-plan office, respectively. The speech transmission indices were 0.00, 0.30 and 0.80, respectively. Sounds environments were presented at 48 dBA. The laboratory experiment on 36 subjects lasted for 4 h for each subject. Proofreading performance deteriorated in the 'speech' (p

- **Keywords:** Speech intelligibility; Noise; Speech; Open-plan offices; Distraction;

Kumar, Shrawan; Fagarasanu, Mircea; Narayan, Yogesh; Prasad, Narasimha. Measures of localized spinal muscle fatigue. S. 1092-1110(19).

Abstract: The objective of this study was to determine the best variable, if any, to indicate the level of localized muscle fatigue. Six male and six female subjects were studied while they exerted their maximal voluntary contraction and 40% of maximal voluntary contraction of spinal extensors in an isometric lifting activity. The electromyography (EMG) of erector spinae at thoracic and lumbar levels was measured bilaterally. Also, the muscle bed blood volume, level of blood oxygenation to erector spinae at L3 level and heart rate were measured. The initial and final values of subjective feelings of fatigue through visual analogue score, rate of perceived exertions and body part discomfort rating were recorded. The mean maximal voluntary contraction forces for males and females were 899 (238) N and 431 (135) N respectively. The mean durations of hold in maximal voluntary fatiguing contraction were 68.1 (39.9) s and 72.3 (37.0) s for men and women respectively. By the end of the hold the force declined to 52% for males and 62% for females. The EMG amplitudes and median frequencies also progressively declined (p

- **Keywords:** Localized muscle fatigue; Erectores spinae; EMG median frequency; Muscle bed blood volume; Blood oxygenation

Goosey-Tolfrey, Victoria; Lenton, John. A comparison between intermittent and constant wheelchair propulsion strategies. S. 1111-1120(10).

Abstract: The purpose of this study was to investigate the effect of different synchronous push strategies on physiological parameters and temporal timing characteristics. Eight novice male able-bodied participants completed four counter-balanced conditions: two push strategies (constant pushing) and intermittent pushing (INT) at two push frequencies (40 and 70 pushes/min) at 27 W. The ANOVA main effects for frequency indicated that regardless of push strategy, oxygen cost and mechanical efficiency increased with an increase in push frequency (p

- **Keywords:** Push frequency; Synchronous push strategies

Mogk, Jeremy; Keir, Peter. Prediction of forearm muscle activity during gripping. S. 1121-1130(10).

Abstract: Occupational exposure is typically assessed by measuring forces and body postures to infer muscular loading. Better understanding of workplace muscle activity levels would aid in indicating which muscles may be at risk for overexertion and injury. However, electromyography collection in the workplace is often not practical. Therefore, a set of equations was developed and validated using data from two separate days to predict forearm muscle activity (involving six wrist and finger muscles) from grip force and posture of the wrist (flexed, neutral and extended) and forearm (pronated, neutral, supinated). The error in predicting activation levels of each forearm muscle across the range of grip forces, using the first day data (root mean square error; RMSE model), ranged from 8.9% maximal voluntary electrical activation (MVE) (flexor carpi radialis) to 11% MVE (extensor digitorum communis). Grip force was the main contributor to predicting muscle activity levels, explaining over 70% of the variance in flexor activation levels and up to 60% in extensor activation levels, respectively. Inclusion of gender as a variable in the model improved estimates of flexor but not extensor activity. While posture itself explained minimal variance in activation without grip force (

- **Keywords:** Grip force; EMG; Posture; Regression; Prediction; Ergonomic tool

🚩 Číslo 12-13 (October 2006)

Stanton, Neville; Baber, Chris. The ergonomics of command and control. S. 1131-1138(8).

Riley, Jennifer; Endsley, Mica; Bolstad, Cheryl; Cuevas, Haydee. Collaborative planning and situation awareness in Army command and control. S. 1139-1153(15).

Abstract: We conducted a theoretical investigation of a complex command and control (C2) operation—the manoeuvres planning processes in Army land-battle situations, to improve understanding of how technology can best be designed to support planning and course of action development. We drew upon results from cognitive task analyses and interviews with subject matter experts and insights gleaned from observations of Army training exercises and experiments to make inferences on the C2 activities carried out in preparation for tactical manoeuvres. In this paper, we summarize several critical human factors issues associated with planning in a rapidly evolving environment, as identified in our investigation, and describe system design concepts aimed at addressing these challenges to distributed collaborative planning of C2 activities. We conclude with implications for the application of these findings to other C2 domains.

- **Keywords:** Command and control; Planning; Collaboration; Situation awareness

Thomas, Lisa; Wickens, Christopher. Effects of battlefield display frames of reference on navigation tasks, spatial judgements, and change detection. S. 1154-1173(20).

Abstract: This paper describes an experiment which illustrates the cause of 'cognitive tunnelling' as it affects information gathering and perception-based task performance in computer-generated terrain displays of varying frames of reference. Cognitive tunnelling refers to the effect where observers focus attention on information from specific areas of a display to the exclusion of information presented outside these areas. Previous research suggests that cognitive tunnelling is induced by more immersive or egocentric visual displays. Results from our preceding study suggested that an immersed split-screen display induces cognitive tunnelling and results in poorer information extraction and situation awareness than an exocentric display of the same information. The current study determined that failure of the observers to integrate information across the two views of the immersed display led to the cognitive tunnelling effect. Cognitive tunnelling was also affected by primacy of information initially presented within the larger egocentric view in the immersed display.

- **Keywords:** Frames of reference; Terrain displays; Cognitive tunnelling

Furniss, Dominic; Blandford, Ann. Understanding emergency medical dispatch in terms of distributed cognition: a case study. S. 1174-1203(30).

Abstract: Emergency medical dispatch (EMD) is typically a team activity, requiring fluid coordination and communication between team members. Such working situations have often been described in terms of distributed cognition (DC), a framework for understanding team working. DC takes account of factors such as shared representations and artefacts to support reasoning about team working. Although the language of DC has been developed over several years, little attention has been paid to developing a methodology or reusable representation which supports reasoning about an interactive system from a DC perspective. We present a case study in which we developed a method for constructing a DC account of team working in the domain of EMD, focusing on the use

of the method for describing an existing EMD work system, identifying sources of weakness in that system, and reasoning about the likely consequences of redesign of the system. The resulting DC descriptions have yielded new insights into the design of EMD work and of tools to support that work within a large EMD centre.

- **Keywords:** Emergency medical dispatch; Distributed cognition; Team working; Ambulance control; Human-computer interaction

Houghton, Robert; Baber, Chris; McMaster, Richard; Stanton, Neville; Salmon, Paul; Stewart, Rebecca; Walker, Guy. Command and control in emergency services operations: a social network analysis. S. 1204-1225(22).

Abstract: There is increasing interest in the use of social network analysis as a tool to study the performance of teams and organizations. In this paper, processes of command and control in the emergency services are explored from the perspective of social network theory. We report a set of network analyses (comprising visualization, a selection of mathematical metrics, and a discussion of procedures) based on the observation of six emergency service incidents: three fire service operations involving the treatment of hazardous chemicals, and three police operations involving immediate response to emergency calls. The findings are discussed in terms of our attempts to categorize the network structures against a set of extant command and control network archetypes and the relationship between those structures; comments on the qualities the networks display are put into the contexts of the incidents reported. We suggest that social network analysis may have a valuable part to play in the general study of command and control.

- **Keywords:** Emergency response; Command and control; Social networks; Teams

Svensson, Jonathan; Andersson, Jan. Speech acts, communication problems, and fighter pilot team performance. S. 1226-1237(12).

Abstract: Two aspects of team communication, speech acts and communication problems, and their relation to team performance in a team air combat simulator were studied. The purpose was to enhance the understanding of how team performance is related to team communication. Ten Swedish fighter pilots and four fighter controllers of varying experience participated. Data were collected during fighter simulator training involving four pilots and one fighter controller in each of two teams. Speech acts were collapsed over seven categories and communication problems over five categories. Communication was studied from two perspectives: critical situation outcome and mission outcome. Some problems were closely related to particular speech acts. Speech act frequency, especially meta-communications and tactics, was highest when winning. However, the timing of tactics in critical situations needs further research. Communication problem frequency was highest for runs which ended equally. The most common problem was simultaneous speech, possibly because of the simulator radio system. The number of speech acts was related to enhanced performance but in a complex manner. Thus in order to work efficiently team members need to communicate, but to communicate sufficiently and at appropriate times. This work has applications for fighter pilot and controller team training and the development of communication standards.

- **Keywords:** Communication analysis; Performance measurement; Team training; BVR air combat; Quantitative content analysis

Grootjen, M.; Neerincx, M.; Veltman, J. Cognitive task load in a naval ship control centre: from identification to prediction. S. 1238-1264(27).

Abstract: Deployment of information and communication technology will lead to further

automation of control centre tasks and an increasing amount of information to be processed. A method for establishing adequate levels of cognitive task load for the operators in such complex environments has been developed. It is based on a model distinguishing three load factors: time occupied, task-set switching, and level of information processing. Application of the method resulted in eight scenarios for eight extremes of task load (i.e. low and high values for each load factor). These scenarios were performed by 13 teams in a high-fidelity control centre simulator of the Royal Netherlands Navy. The results show that the method provides good prediction of the task load that will actually appear in the simulator. The model allowed identification of under- and overload situations showing negative effects on operator performance corresponding to controlled experiments in a less realistic task environment. Tools proposed to keep the operator at an optimum task load are (adaptive) task allocation and interface support.

- **Keywords:** Mental load; Task analysis; Human-computer interaction; Cognitive engineering; Task allocation; Ship control centre

Gregoriades, A.; Sutcliffe, A. Automated assistance for human factors analysis in complex systems. S. 1265-1287(23).

Abstract: A tool and a method for scenario-based workload assessment and performance validation in complex socio-technical systems design, such as command and control rooms of military vessels, are described. We assess workload in terms of communication and the task load that each agent is able to handle. The method employs subjective task and communication estimates used to calculate the workload of human operators, using static and scenario-based analyses. This enables the identification of bottlenecks to be addressed by the designer with the appropriate allocation of function between humans and smart technology. This task is supported by the functional allocation adviser tool. A case study demonstrating the use of the tool for the design of the command and control room of a military vessel is presented.

- **Keywords:** Socio-technical systems design; Human performance; Workload assessment; Functional allocation

Stanton, N.; Stewart, R.; Harris, D.; Houghton, R.; Baber, C.; McMaster, R.; Salmon, P.; Hoyle, G.; Walker, G.; Young, M.; Linsell, M.; Dymott, R.; Green, D. Distributed situation awareness in dynamic systems: theoretical development and application of an ergonomics methodology. S. 1288-1311(24).

Abstract: The purpose of this paper is to propose foundations for a theory of situation awareness based on the analysis of interactions between agents (i.e. both human and non-human) in subsystems. This approach may help to promote a better understanding of technology-mediated interaction in systems, as well as helping in the formulation of hypotheses and predictions concerning distributed situation awareness. It is proposed that agents within a system each hold their own situation awareness, which may be very different from (although compatible with) that of other agents. It is argued that we should not always hope for, or indeed want, sharing of this awareness, as different system agents have different purposes. This view marks situation awareness as a dynamic and collaborative process binding agents together on tasks on a moment-by-moment basis. Implications of this viewpoint for the development of a new theory of, and accompanying methodology for, distributed situation awareness are offered.

- **Keywords:** Agents; Systems theory; Command and control; Situation awareness; Teams

Gorman, Jamie; Cooke, Nancy; Winner, Jennifer. Measuring team situation awareness in decentralized command and control environments. S. 1312-1325(14).

Abstract: Decentralized command and control settings like those found in the military are rife with complexity and change. These settings typically involve dozens, if not hundreds to thousands, of heterogeneous players coordinating in a distributed fashion in a dynamically networked battlefield laden with sensor data, intelligence reports, communications, and plans emanating from many different perspectives. Consider the concept of team situation awareness in this setting. What does it mean for a team to be aware of a situation or, more importantly, of a critical change in a situation? Is it sufficient or necessary for all individuals on the team to be independently aware? Or is there some more holistic awareness that emerges as team members interact? We re-examine the concept of team situation awareness in decentralized systems beyond an individual-oriented knowledge-based construct by considering it as a team interaction-based phenomenon. A theoretical framework for a process-based measure called 'coordinated awareness of situations by teams' is outlined.

- **Keywords:** Teams; Situation awareness; Command and control; Team cognition

Shorrock, S.; Straeter, O. A framework for managing system disturbances and insights from air traffic management. S. 1326-1344(19).

Abstract: System disturbances are likely to be a key factor affecting the acceptance and safety of future automation. Since hardware and software are rarely totally reliable, humans are always required in socio-technical command and control environments such as air traffic management (ATM). Unfortunately, human-automation interaction is known to be problematic, particularly when the human assumes a monitoring or back-up role. Hence an understanding of how humans manage system disturbances is required, together with a method of looking at the problem for new systems. In this paper we outline a contextual framework of the process by which people recover from system disturbances, together with literature data and findings from 31 interviews with ATM personnel. The framework describes the context and causes of a problem, the problem itself, the effect and exposure, the recovery process, and the outcome. The framework, together with the research findings and operational experience, is also the basis for a performance prediction tool called the Recovery from Automation Failure Tool (RAFT).

- **Keywords:** Automation; Managing system disturbances; Air traffic management; Air traffic control; Recovery

Walker, Guy; Gibson, Huw; Stanton, Neville; Baber, Chris; Salmon, Paul; Green, Damian. Event analysis of systemic teamwork (EAST): a novel integration of ergonomics methods to analyse C4i activity. S. 1345-1369(25).

Abstract: C4i is defined as the management infrastructure needed for the execution of a common goal supported by multiple agents in multiple locations and technology. In order to extract data from complex and diverse C4i scenarios a descriptive methodology called Event Analysis for Systemic Teamwork (EAST) has been developed. With over 90 existing ergonomics methodologies already available, the approach taken was to integrate a hierarchical task analysis, a coordination demand analysis, a communications usage diagram, a social network analysis, and the critical decision method. The outputs of these methods provide two summary representations in the form of an enhanced operation sequence diagram and a propositional network. These offer multiple overlapping perspectives on key descriptive constructs including who the agents are in a scenario, when tasks occur, where agents are located, how agents collaborate and communicate, what information is used, and what knowledge is shared. The application of these methods to live data drawn from the UK rail industry demonstrates how alternative scenarios can be compared on key metrics, how multiple perspectives on the same data can be taken, and what further detailed insights can be extracted. The ultimate aim of EAST is, by applying it across a number of scenarios in different civil and military domains, to provide data to develop generic models of C4i activity and to improve the

design of systems aimed at enhancing this management infrastructure.

- **Keywords:** Event analysis; Teamwork; Hierarchical task analysis; Coordination demand analysis; Communications usage diagram; Social network analysis; Critical decision method; Rail industry

Farrington-Darby, T.; Wilson, John; Norris, B.; Clarke, Theresa. A naturalistic study of railway controllers.S . 1370-1394(25).

Abstract: There is an increasing prevalence for work to be analysed through naturalistic study, especially using ethnographically derived methods of enquiry and qualitative field research. The relatively unexplored domain of railway control (in comparison to signalling) in the UK is described in terms of features derived from observations and semi-structured interviews. In addition, task diagrams (a technique taken from the Applied Cognitive Task Analysis toolkit) are used to represent controllers' core elements of work, i.e. to manage events or incidents, and to identify the challenging steps in the process. The work features identified, the task diagrams, and the steps identified as challenging form a basis from which future ergonomics studies on railway controllers in the UK will be carried out.

- **Keywords:** Rail; Control; Ethnography; Naturalistic; Domain analysis; Cognitive task analysis

Patrick, J.; James, N.; Ahmed, A. Human processes of control: tracing the goals and strategies of control room teams. S. 1395-1414(20).

Abstract: This study utilized a process tracing methodology to analyse the goals and strategies of control room teams in dealing with an unpredicted plant disturbance. The human processes of control used by operators and their supervisors, and interactions between them, were analysed during phases of detection, diagnosis, and control of a small plant leak. Five control room teams were videotaped tackling this simulated scenario on a full-scale simulator. The results found substantial differences both within and between teams in how the goals of monitoring and implementing procedures during the detection phase, and problem-solving and plant control during the diagnosis phase were achieved. The temporal patterning of the activities associated with these goals revealed that the teams used different strategies. The training implications of these findings are discussed, in particular with respect to the control room supervisor who had a pivotal role.

- **Keywords:** Process tracing; Teams; Detection; Diagnosis; Monitoring; Command and control

Ntuen, Celestine; Balogun, Obafemi; Boyle, Edward; Turner, Amy. Supporting command and control training functions in the emergency management domain using cognitive systems engineering. S. 1415-1436(22).

Abstract: The design and implementation of MERMAIDS, a computer-based training system in the domain of emergency command and control, is described. The research investigates the use of cognitive systems engineering and information management tools for modelling and representing training knowledge of emergency system operators. We propose a decision-centric human-computer interface as a new method of supporting computer-based modelling in the domain of emergency systems. Several interacting themes in information management relevant to emergency response planning are discussed.

- **Keywords:** Decision support system; Emergency response; Command and control; Information analysis; Interface; Planning

✚ Číslo 14 (November 2006)

Vi, Peter. A field study investigating the effects of a rebar-tying machine on trunk flexion, tool usability and productivity. S. 1437-1455(19).

Abstract: A field study with a before-and-after experimental design was conducted to evaluate the potential reduction in the risk of musculoskeletal injuries to rodworkers when using an automatic rebar-tying machine. Eleven rodworkers participated in this experiment. All dependent variables (trunk posture, rebar-tying time and responses to a usability questionnaire) were first measured before introducing the rebar-tying machine and then after 3 months of usage all dependent variables were measured again. The results of the study indicated that working with a rebar-tying machine significantly reduced the magnitude, frequency and duration of exposure to awkward trunk posture. Tying time was reduced when participants used the machine. The usability questionnaire indicated that most participants preferred to use the rebar-tying machine for ground-level rebar construction. The field study also revealed that the rebar-tying machine is not limited to the reinforcing trade. The machine can be used for other purposes, such as tying electrical conduit and attaching radiant heat tube to steel mesh. Based on trunk posture exposure, rebar-tying time, usability and transferability, it is concluded that the rebar-tying machine can be an effective tool to reduce the frequency and duration of severe trunk flexion, improve usability and increase productivity among concrete reinforcement workers.

- **Keywords:** Construction; Concrete reinforcement; Rodworkers; Intervention; Rebar tying; Posture; Usability; Back; Upper extremity

Dennerlein, Jack; Johnson, Peter. Changes in upper extremity biomechanics across different mouse positions in a computer workstation. S. 1456-1469(14).

Abstract: In order to determine differences in biomechanical risk factors across different mouse positions within computer workstations a repeated measures laboratory study was completed with 30 adults (15 females 15 males). The subjects performed mouse-intensive tasks during two experiments. One experiment examined three mouse positions: a standard mouse (SM) position with the mouse directly to the right of the keyboard; a central mouse (CM) position with the mouse between the keyboard and the body, positioned in the body's mid-sagittal plane; a high mouse (HM) position, which simulated using a keyboard drawer with the mouse on the primary work surface. The second experiment compared two mouse positions: the SM position and a more central position using a keyboard without a number keypad (NM). Electrogoniometers and inclinometers measured wrist and upper arm postures and surface electromyography measured muscle activity of four forearm muscles and three shoulder muscles. The CM mouse position was found to produce the most neutral upper extremity posture across all measures. The HM position produced the least neutral posture and resulted in the highest level of muscle activity. Compared to the SM position, the NM position reduced wrist extension slightly and promoted a more neutral shoulder posture. Little difference in muscle activity was observed between the SM and NM positions. In conclusion, of these alternative mouse positions, the HM position was the least desirable, whereas the CM position reduced overall awkward postures associated with mouse-intensive computer tasks.

- **Keywords:** Workstation design; Computer mouse; Upper extremity biomechanics

Drury, Colin; Atilas, Moises; Chaitanya, Mohan; Lin, Jui-Feng; Marin, Clara; Nasarwanji, Mahiyar; Paluszak, Doug; Russell, Casey; Stone, Richard; Sunm, Michelle. Vicarious perception of postural discomfort and exertion. S. 1470-

1485(16).

Abstract: Perceived exertion and discomfort have been used extensively in ergonomics practice. Job incumbents typically rate their exertion on scales such as Borg's rated perceived effort (RPE) and their discomfort on scales such as Corlett and Bishop's body part discomfort scales (BPD). This study asks whether exertion and discomfort can be perceived by an external observer, i.e. is vicarious perception possible? Four participants (targets) performed 20 postural holding tasks selected from Ovako Working Posture Analysing System postures and gave RPE and BPD scores for each posture. Video clips of each target in each posture were shown to four expert ergonomists and 23 novices, who also gave RPE and BPD scores. Correlations between targets and observers scores were high, with significance exceeding $p = 0.01$. Observers were generally conservative, rating easy postures too high and difficult postures too low. All observers rated female targets higher than male targets. Female observers rated all targets higher than male observers. Vicarious perception of discomfort and exertion was possible, but there was not a one-to-one correspondence to ratings given by those experiencing the posture.

- **Keywords:** Vicarious perception; Discomfort; Exertion

Bernmark, Eva; Wiktorin, Christina; Svartengren, Magnus; Lewné, Marie; Åberg, Samuel. Bicycle messengers: energy expenditure and exposure to air pollution. S. 1486-1495(10).

Abstract: The purpose of the study was to determine the level of energy expenditure and exposure to air pollution for bicycle messengers. Relationships between heart rate (HR) and oxygen uptake, and between HR and pulmonary ventilation (VE) for each participant were established in laboratory tests. Air pollution and HR were measured during one working day. The total oxygen uptake was then described as the total energy expenditure in Joule (J) and in multiples of the energy expenditure at rest (MET). The mean energy expenditure during a working day (8 h) was 12 MJ, (4.8 MET). The level of air pollution exposure when cycling seemed to be comparable with the levels of exposure when sitting inside a vehicle. The VE during cycling was four times higher than resting value. Increased VE led to increased exposure to air pollution.

- **Keywords:** Heart rate; Oxygen consumption; Pulmonary ventilation; Occupational exposure

Küller, Rikard; Ballal, Seifeddin; Laike, Thorbjörn; Mikellides, Byron; Tonello, Graciela. The impact of light and colour on psychological mood: a cross-cultural study of indoor work environments. S. 1496-1507(12).

Abstract: The aim of the study was to determine whether indoor lighting and colour would have any systematic impact on the mood of people working indoors. Earlier studies have mostly focused either on light, colour or windows in laboratory settings. The present study was carried out in real work environments at different seasons and in countries with different latitudes. A total of 988 persons completed all parts of the study. In the countries situated far north of the equator there was a significant variation in psychological mood over the year that did not occur in the countries closer to the equator. When all four countries were considered together, it became evident that the light and colour of the workplace itself also had an influence on the mood of persons working there. The workers' mood was at its lowest when the lighting was experienced as much too dark. The mood then improved and reached its highest level when the lighting was experienced as just right, but when it became too bright the mood declined again. On the other hand, the illuminance as measured in objective terms, showed no significant impact on mood at any time of the year. The relationship between mood and the distance to the nearest window was bimodal. The results also indicate that the use of good colour design might contribute to a more positive mood. It is suggested that in

future research light and colour should be studied as parts of the more complex system making up a healthy building.

- **Keywords:** Artificial lighting; Daylight; Interior colour; Psychological mood; Windows; Work environments

Boag, Christine; Neal, Andrew; Loft, Shayne; Halford, Graeme. An analysis of relational complexity in an air traffic control conflict detection task. S. 1508-1526(19).

Abstract: Theoretical analyses of air traffic complexity were carried out using the Method for the Analysis of Relational Complexity. Twenty-two air traffic controllers examined static air traffic displays and were required to detect and resolve conflicts. Objective measures of performance included conflict detection time and accuracy. Subjective perceptions of mental workload were assessed by a complexity-sorting task and subjective ratings of the difficulty of different aspects of the task. A metric quantifying the complexity of pair-wise relations among aircraft was able to account for a substantial portion of the variance in the perceived complexity and difficulty of conflict detection problems, as well as reaction time. Other variables that influenced performance included the mean minimum separation between aircraft pairs and the amount of time that aircraft spent in conflict.

- **Keywords:** Relational complexity; Mental workload; Air traffic control; Conflict detection

Attwells, Renee; Birrell, Stewart; Hooper, Robin; Mansfield, Neil. Influence of carrying heavy loads on soldiers' posture, movements and gait. S. 1527-1537(11).

Abstract: Military personnel are required to carry heavy loads whilst marching; this load carriage represents a substantial component of training and combat. Studies in the literature mainly concentrate on physiological effects, with few biomechanical studies of military load carriage systems (LCS). This study examines changes in gait and posture caused by increasing load carriage in military LCS. The four conditions used during this study were control (including rifle, boots and helmet carriage, totalling 8 kg), webbing (weighing 8 kg), backpack (24 kg) and a light antitank weapon (LAW; 10 kg), resulting in an incremental increase in load carried from 8, 16, 40 to 50 kg. A total of 20 male soldiers were evaluated in the sagittal plane using a 3-D motion analysis system. Measurements of ankle, knee, femur, trunk and craniovertebral angles and spatiotemporal parameters were made during self-paced walking. Results showed spatiotemporal changes were unrelated to angular changes, perhaps a consequence of military training. Knee and femur ranges of motion (control, $21.1^\circ \pm 3.0$ and $33.9^\circ \pm 7.1$ respectively) increased (p

- **Keywords:** Posture; Load carriage; Military; Gait

Corlett, E. Background to sitting at work: research-based requirements for the design of work seats. S.. 1538-1546(9).

Abstract: The body's responses to sitting are complex and involve the anatomy and physiology of the sitter as well as the structure of the seat, the desk and the environment. In the light of recent research, the major reactions of the spine, the muscles and the spinal discs are discussed. Their interactions when adopting sitting postures are described. Reasons are given why certain sitting postures are to be preferred. The mechanisms that may give rise to muscle and disc damage, as well as back pain, as a result of adverse sitting postures are outlined. The design consequences of the research are then presented, showing how the seat shape arises from the

previously described data. The influence of backrest design on sitting comfort and in the reduction of loading on the body is shown. Finally, a brief discussion of the influences from the work surface illustrates how the combination of seat and workplace can reduce the risks of injury by mitigating body loadings over the working day.

- **Keywords:** Chair design; Back pain; Sitting at work; Spinal loading

🚩 Číslo 15 (December 2006)

Bertrand, Samuel; Skalli, Wafa; Delacherie, Laurent; Bonneau, Dominique; Kalifa, Gabriel; Mitton, David. External and internal geometry of European adults. S. 1547-1564(18).

Abstract: The primary objective of the study was to bring a deeper knowledge of the human anthropometry, investigating the external and internal body geometry of small women, mid-sized men and tall men. Sixty-four healthy European adults were recruited. External measurements were performed using classical anthropometric instruments. Internal measurements of the trunk bones were performed using a stereo-radiographic 3D reconstruction technique. Besides the original procedure presented in this paper for performing in vivo geometrical data acquisition on numerous volunteers, this study provides an extensive description of both external and internal (trunk skeleton) human body geometry for three morphotypes. Moreover, this study proposes a global external and internal geometrical description of 5th female 50th male and 95th male percentile subjects. This study resulted in a unique geometrical database enabling improvement for numerical models of the human body for crash test simulation and offering numerous possibilities in the anthropometry field.

- **Keywords:** Anthropometry; Morphotype; Stereo-radiography; 3D reconstruction; Trunk skeleton; Biomechanics

Park, W.; Singh, D.; Martin, B. J. A memory-based model for planning target reach postures in the presence of obstructions. S. 1565-1580(16).

Abstract: Existing posture prediction and motion simulation models generally lack the capability of simulating human obstruction avoidance during target reach. This compromises the utility of digital human models for ergonomics, as many design problems involve interactions between humans and obstructions. To address this problem, this paper presents a novel memory-based posture planning (MBPP) model, which plans reach postures that avoid obstructions. In this model, the task space is partitioned into small regions called cells. For a given human figure, each cell is linked to a memory that stores various alternative postures for reaching the cell. When a posture planning problem is given in terms of a target and an obstruction configuration, the model examines postures belonging to the relevant cell, selects collision-free ones and modifies them to exactly meet the hand target acquisition constraint. Simulation results showed that the MBPP model is capable of rapidly and robustly planning reach postures for various scenarios.

- **Keywords:** Memory-based; Posture planning; Obstruction avoidance; Ergonomic design; Digital human models

Morris, Charles H.; Leung, Ying K. Pilot mental workload: how well do pilots really perform? S. 1581-1596(16).

Abstract: The purpose of this study was to investigate the effects of increasing mental demands on various aspects of aircrew performance. In particular, the robustness of the

prioritization and allocation hierarchy of aviation tasks (navigate, communicate) was examined, a hierarchy commonly used within the aviation industry. A total of 42 trainee pilots were divided into three workload groups (low, medium, high) to complete a desktop, computer-based exercise that simulated combinations of generic flight deck activities: flight control manipulation, rule-based actions and higher level cognitive processing, in addition to Air Traffic Control instructions that varied in length from one chunk of auditory information to seven chunks. It was found that as mental workload and auditory input increased, participants experienced considerable difficulty in carrying out the primary manipulation task. A similar decline in prioritization was also observed. Moreover, when pilots were under a high mental workload their ability to comprehend more than two chunks of auditory data deteriorated rapidly.

- **Keywords:** Mental workload; Cockpit task management; Flight safety

Edworthy, Judy; Waring, Hannah. The effects of music tempo and loudness level on treadmill exercise. S. 1597-1610(14).

Abstract: This study examined the effects of loudness and tempo of background music on exercise performance. A total of 30 volunteers performed five 10-min exercise sessions on a treadmill. The music listened to whilst exercising was either fast/loud, fast/quiet, slow/loud, slow/quiet or absent. Measures of running speed, heart rate, perceived exertion and affect were taken. Significant effects and interactions were found for running speed and heart rate across the different music tempo and loudness levels. More positive affect was observed during the music condition in comparison to the 'no music' condition. No significant differences for perceived exertion were found across conditions. These results confirm that fast, loud music might be played to enhance optimal exercising, and show how loudness and tempo interact.

- **Keywords:** Music; Exercise; Heart rate; Affect; Perceived exertion

Hendriks, H. M.; Spoor, C. W.; de Jong, A. M.; Goossens, R. H. M. Stability of sitting postures: the influence of degrees of freedom. S. 1611-1626(16).

Abstract: Observational studies of sitting have shown that, during spontaneous sitting, people adopt a variety of postures. Various researchers have formulated theories to explain why people adopt their sitting postures. Branton (1969) hypothesized that there is continual need for postural stability while sitting. Dempster (1955) stated that additional stability could be obtained through temporarily closing chains of body segments, or, in other words, through decreasing the number of degrees of freedom of the body. The present study elaborates on Dempster's theory. The aim of this study was to determine the influence of the degrees of freedom of the body on postural stability in sitting postures. For 21 different sitting postures, the total number of degrees of freedom was determined. Postural sway, a measure for postural stability, was determined using a 3D motion and position measurement system with ten healthy subjects. This study shows that the mean path length at the level of the second thoracic vertebra, a measure derived from postural sway, increases significantly ($p < 0.0001$) with an increase of the number of degrees of freedom of the body (DoF B). Closer examination of the data showed that a model taking into account only the degrees of freedom of the lumbar and thoracic spine and pelvis seems to be a better predictor of postural sway than the total number of degrees of freedom of the body.

- **Keywords:** Postural stability; Postural sway; Closed-chain theory; Degrees of freedom; Sitting behaviour; Observational studies

Visser, Bart; Nielsen, Pernille Kofoed; de Kraker, Heleen; Smits, Miriam; Jensen, Bente Rona; Veeger, DirkJan; van Dieën, Jaap H. The effects of shoulder load and pinch force on electromyographic activity and blood flow in the forearm during

a pinch task. S. 1627-1638(12).

Abstract: The object of the current study was to determine whether static contraction of proximal musculature has an effect on the blood flow more distally in the upper extremity. Static contractions of muscles in the neck-shoulder region at three levels (relaxed, shoulders elevated and shoulders elevated loaded with 4.95 kg each) were combined with intermittent pinch forces at 0, 10 and 25% of the maximum voluntary contraction (MVC). Blood flow to the forearm was measured with Doppler ultrasound. Myoelectric activity of the forearm and neck-shoulder muscles was recorded to check for the workload levels. Across all levels of shoulder load, blood flow increased significantly with increasing pinch force (21% at 10% MVC and by 44% at 25% MVC). Blood flow was significantly affected by shoulder load, with the lowest blood flow at the highest shoulder load. Interactions of pinch force and shoulder load were not significant. The myoelectric activity of forearm muscles increased with increasing pinch force. The activation of the trapezius muscle decreased with increasing pinch force and increased with increasing shoulder load. The precise mechanisms accounting for the influence of shoulder load remains unclear. The results of this study indicate that shoulder load might influence blood flow to the forearm.

- **Keywords:** Upper extremity musculoskeletal disorders; Electromyography; Blood flow; Computer work

Pline, Kevin M.; Madigan, Michael L.; Nussbaum, Maury A. Influence of fatigue time and level on increases in postural sway. S. 1639-1648(10).

Abstract: The purpose of this study was to investigate the influence of fatigue time and fatigue level on the increases in postural sway during quiet standing. Centre of pressure-based measures of postural sway were collected both before and after fatiguing participants using three different fatigue levels and two different fatigue times. Results showed increasing fatigue time increased sway velocity and sway area, and increasing fatigue level increased sway velocity. Fatigue time effects are important to consider when applying laboratory-based findings to the field given that the fatigue time can differ substantially between the two. Fatigue level effects imply a dose-response relationship between localized muscle fatigue and risk of falling that can have important implications in work/rest cycle scheduling for occupations at risk of injurious falls.

- **Keywords:** Accidental falls; Muscle fatigue; Postural balance