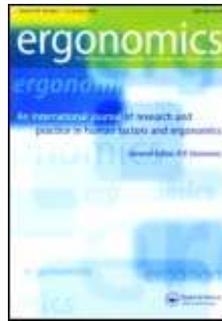


Ergonomics– rok 2007, ročník 50

Číslo 12



M. A. Sinclair. *Ergonomics issues in future systems. S. 1957 – 1986.*

The paper starts by discussing some of the historical background to the design of systems and the development of systems thinking, from the perspective of Ergonomics. This is followed by an attempt to describe the likely future for systems design and operation; critical points being that these systems will interoperate with other systems; they will be long-lived; and we cannot afford for them to fail. This leads on to a discussion of complexity and its effects. The paper then goes on to discuss how and why Ergonomics practitioners should be interested in these effects. This includes dealing with intrinsic complexity (inherent in the purposes of the system) and induced complexity (introduced by the the organization, process design and operation of the system), the significance of trust, shared situation awareness and sense-making, the need for excellent communications, the importance of knowledge, experience and governance. Finally, a brief section, pointing to other sources, outlines possible approaches for designing these future systems.

- **Keywords:** System-of-systems; Complexity; Socio-technical systems theory; Trust, Sense-making

C. D. Frowd; D. McQuiston-Surrett; S. Anandaciva; C. G. Ireland; P. J. B. Hancock. *An evaluation of US systems for facial composite production. S. 1987 – 1998.*

Witness and victims of serious crime are normally requested to construct a facial composite of a suspect's face. While modern systems for constructing composites have been evaluated extensively in the UK, this is not the case in the US. In the current work, two popular computerized systems in the US, FACES and Identikit 2000, were evaluated against a 'reference' system, PRO-fit, where performance is established. In experiment 1, witnesses constructed a composite with both PRO-fit and FACES using a realistic procedure. The resulting composites were very poorly named, but the PRO-fit emerged best in 'cued' naming and two supplementary measures: composite sorting; and likeness ratings. In experiment 2, PRO-fit was compared with Identikit 2000, a sketch-like feature system. Spontaneous naming was again very poor, but both cued naming and sorting suggested that the systems were similar. The results support previous findings that modern systems do not produce identifiable composites.

- **Keywords:** Facial composite; Witness; Evaluation; Interview; Crime

C. Sutter. *Sensumotor transformation of input devices and the impact on practice and task difficulty*. S. 1999 – 2016.

In the present study, the usability of two laptop input devices, touchpad and trackpoint, is evaluated. The focus is set on the impact of sensumotor transformation of input devices on practice and task difficulty. Thirty novices and 14 experts operated either touchpad or trackpoint over a period of 1600 trials of a point-click task. As hypothesized, novices and experts operated the touchpad by 15% faster compared to the trackpoint. For novices, performance rose distinctly and levelled off after 960 trials. This consolidation occurred earlier than reported in literature (1400-1600 trials) and, contrary to the assumption, learning was similar for touchpad and trackpoint. The impact of task difficulty dropped remarkably by practice, which points at a more general than specific task learning. In conclusion, ergonomic guidelines can be derived for the user-specific optimization of the usage of touchpad and trackpoint. Actual and potential applications of this research include the user-specific optimization of laptop input devices. Within the theoretical framework of psychomotor models, a profound knowledge of user behaviour in human - computer interaction is provided. Ergonomic guidelines can be derived for the efficient usage of laptop input devices and an optimized hardware and software design.

- **Keywords:** Input device; Sensumotor transformation; Motor skill learning; Practice; Task difficulty

P. M. C. Lemmens; A. de Haan; G. P. van Galen; R. G. J. Meulenbroek. *Emotionally charged earcons reveal affective congruency effects*. S. 2017 – 2025.

In the present study, the affective impact of earcons on stimulus classification is investigated. We show, using a picture-categorization task, that the affective connotation of earcons in major and minor mode (representing positive and negative valence, respectively) can be congruent or incongruent with response valence. Twenty participants classified pictures of animals and instruments in 256 trials, using positive and negative Yes or No responses. Together with the pictures, either a chord in major mode or minor mode was played. The affective valence of the chords either did or did not match the valence of responses. Response-time latencies show congruency effects of the matching and non-matching sound and response valences, indicating that it is important to carefully investigate human-computer interfaces for potential affective-congruency effects, as these can either facilitate or inhibit user performance.

- **Keywords:** Affective Computing; Stimulus-Response Compatibility; Earcons; Major/Minor Distinction

H. N. J. Schifferstein; P. M. A. Desmet. *The effects of sensory impairments on product experience and personal well-being*. S. 2026 – 2048.

To determine the roles that the sensory modalities play in user - product interactions, one modality was blocked during the execution of eight simple tasks. Participants reported how they experienced the products and how they felt during the experiment. Blocking vision resulted in the largest loss of functional information, increased task difficulty and task duration, and fostered dependency. On the other hand, the other senses were used more and product experiences increased in perceived intenseness. When touch was blocked, the perceived loss of information was smaller and participants reported that familiar products felt less like their own. Blocking audition resulted in communication problems and a feeling of being cut off. Blocking olfaction mainly decreased the intenseness of the experience. These outcomes suggest that vision mainly plays a functional role in everyday user - product interactions, whereas the main role for

olfaction lies in the affective domain. Sensory impairments change the way people experience products. Blocking a single modality during everyday tasks gives insight into the impact of impairments. These insights can be used to develop products for multiple user groups (inclusive design) or products used under extreme environmental conditions.

- **Keywords:** Perception; Product experience; Sensory deprivation; Disability; Multisensory

S. Rietveld; I. van Beest; J. H. Kamphuis. *Stress-induced muscle effort as a cause of repetitive strain injury?* S. 2049 – 2058.

The influence of stress-induced muscle effort during computer utilization was tested in patients with repetitive strain injury (RSI). Twenty academic researchers with a formal medical diagnosis of RSI and 20 matched controls, randomly selected from a sample of 71 colleagues with and without RSI, typed after stress (induced via an intelligence/skill task under social pressure) and after relaxation. Results indicated that both groups had more electromyography (EMG) activity in the shoulder muscles during typing after stress than after relaxation, but that patients started with higher baseline muscle activity. Furthermore, EMG activity of different muscle groups during typing after stress correlated among controls, but not among patients. Finally, analysis of intake forms showed that patients scored higher than controls on neuroticism and alexithymia, but not on extraversion, openness, agreeableness and conscientiousness. It was concluded that deviations in muscle activity during computer utilization, as well as neuroticism and alexithymia, may be risk factors for RSI.

- **Keywords:** Repetitive strain injury; Occupational Overuse Syndrome; Cumulative Trauma Disorder; Stress; Muscle tension; Personality

I. Nastasia; M. Lortie; A. Delisle; M. Gagnon. *Perception and biomechanics data in a manual handling task : a comparative study.* S. 2059 – 2081.

This paper explores the use of subjective perception tasks and its correlations with biomechanical data in the evaluation of manual material handling. Three main dimensions were considered for perception: physical regroups sensations issued from a specific body area; operative regroups feelings related to the execution of the task; and performance regroups feelings that involve a judgement on the execution or reflect overall sensations. The following questions were then explored. To what extent are perception data related to biomechanics data? Do both approaches lead to similar conclusions or interpretations when effect of practice, format and off-centre were tested? How can they complement one another? The task consisted of transferring 50 series of three 15 kg loads in order to verify the impact of free practice, format (box/cylinder) and load centre of gravity position. Eleven subjects rated perception on a CR-10 scale (Borg 1982) after each series. The session was completed with an interview on perception. The net resulting moment was systematically found to be the best correlated with data perception. While all physical and performance items corresponded in various ways to biomechanics data, perceptions associated with operative dimension appeared to be less related with biomechanical data. As regards the impact of practice, format and off-centre, both approaches would lead to the same conclusions, except for the effect of the off-centre. Verbal data add rational information about how or why perception can or cannot be reflected in biomechanics data. How both approaches can be matched more closely in manual handling is discussed.

- **Keywords:** Manual material handling; Perception; Biomechanics; Diagnostic

S. Tak; L. Punnett; V. Paquet; S. Woskie; B. Buchholz. Estimation of compressive forces on lumbar spine from categorical posture data. S. 2082 – 2094.

To combine estimates of trunk posture and force into an integrated measure of load on the low back, continuous variables for body angles were estimated by assuming specified distributions within corresponding posture categories with Monte-Carlo (MC) simulation. The estimated posture angles were compared with reference measurements from the Lumbar Motion Monitor and inclinometers. The lumbar compression estimates, generated from simulated posture angles and from direct measurement, were compared. Trunk flexion showed high correlation between direct measurements and simulated angles, as did L5/S1 compression. The MC approach to extracting continuous posture angles from categorized observations did not appear to introduce large error in the variables used to estimate spinal compressive forces. When instrumentation methods of postural assessment are not feasible, a simulation approach combined with biomechanical modelling could be used to integrate multiple external exposure variables into estimates of compressive forces acting on the low back.

- **Keywords:** Posture assessment; Monte-Carlo simulation; Biomechanical modelling; Construction

M. Becker; J. Rothman; A. J. Nelson; R. Freedland; D. Garcia; L. Feit; J. Barth; R. Sabini. *The effects of multifocal refractive lenses on occipital extension and forward head posture during a visual task.* S. 2095 – 2103.

The purpose of this study was to determine if a change in forward head posture and occipital extension occurred in participants who wore multifocal lenses vs. those persons with non-multifocal lenses while performing an 8-min visual reading task on a visual display unit (VDU). Forty-two healthy human participants were recruited for this study. Thirty-three participants completed the study. Fourteen participants wore multifocal lenses and 19 wore frames with non-multifocal lenses. To evaluate the degree of change of forward head posture and occipital extension digital photographs of cervical posture were taken at four different time intervals: prior to performing the reading task and at 3, 5 and 8 min during the reading task. The digital photographs were analysed utilizing a computer program. Two one-way ANOVA were utilized to determine the degree of change of forward head posture and occipital extension between groups. A significant difference was identified between groups for changes in degrees of forward head posture while performing a visual reading task on a VDU. However, no significant difference between groups was found for occipital extension while performing the same task. Multifocal wearers exhibit greater degrees of change in forward head posture and occipital extension than non-multifocal wearers. These postural changes may place them at a greater risk for musculoskeletal disorders and headaches.

- **Keywords:** Multifocal; Forward head posture; Occipital extension; Visual display unit; Ergonomics

A. M. Anderson; K. A. Meador; L. R. McClure; D. Makrozahopoulos; D. J. Brooks; G. A. Mirka. *A biomechanical analysis of anterior load carriage.* S. 2104 – 2117.

Front load carriage is a common occupational task in some industries (e.g. agriculture, construction), but, as compared to lifting tasks, relatively little research has been conducted on the biomechanical loading during these activities. The focus of this study was to explore the low back biomechanics during these activities and, specifically, to examine the effects of load height and walking speed on trunk muscle activity and trunk

posture. Eleven male participants participated in two separate front load-carriage experiments. The first experiment called for carrying a barbell (with weight corresponding to 20% of elbow flexion strength) at three heights (knuckle height, elbow height and shoulder height) at a constant horizontal distance from the spine. The second experiment called for participants to carry a bucket of potatoes weighing 14 kg at the same three heights, but with no further restrictions in technique. In both experiments, the participants performed this task while either standing still or walking at a self-selected speed. As they performed these tasks, the activity levels of the right-side muscle of the rectus abdominis, external oblique, biceps brachii, anterior deltoid and three levels (T9, T12 and L3) of the erector spinae were sampled. Mid-sagittal plane trunk posture was also quantified using three magnetic field-based motion sensors at T9, T12 and L3. The results showed a significant effect of both walking speed and load height on trunk posture and trunk muscle activity levels in both the barbell and bucket experiments. In the barbell experiment, the walking trials generated 43% more trunk muscle activity than the standing trials. Trials at shoulder height produced 11% more muscle activity than trials at elbow height in the T9 erector spinae muscles and 71% more muscle activity in the anterior deltoid. In the bucket experiment, trunk muscle activity responded in a similar fashion, but the key result here was the quantification of the natural hyperextension posture of the spine used to balance the bucket of potatoes. These results provide insight into muscle activation patterns in dynamic settings, especially (load) carrying biomechanics, and have implications in industrial settings that require workers to carry loads in front of their bodies.

- **Keywords:** Lumbar; Electromyography; Motion analysis; Agriculture

S. Bao; N. Howard; P. Spielholz; B. Silverstein. Two posture analysis approaches and their application in a modified Rapid Upper Limb Assessment evaluation. S. 2118 – 2136.

This paper presents two posture risk quantification methods: first, an event-based method where the most common and the worst postures are estimated in a task; second, a time-based method where posture distributions are calculated from random samples of observed postures in the task. A 'click-on-screen' posture data entry method was developed for the time-based posture analysis method to make the observation process easier and to reduce possible posture categorization bias. Both methods were used to quantify various work posture parameters among a study cohort of 733 subjects from a prospective epidemiological study of upper extremity musculoskeletal disorders. Composite posture indices using a modified Rapid Upper Limb Assessment (RULA) method were also computed using data obtained by the two posture analysis methods. Results showed that both methods were able to distinguish jobs with large differences in certain posture measures. However, they did not produce the same results and could not be used interchangeably. Risk evaluation criteria should be developed, either for specific posture parameters or as a composite index, with a well-defined postural analysis method, so that users can follow exact procedures and obtain comparable results. The event-based method is easy to use and may suit practitioners better, while the time-based method adds more information to the measurement and may suit users who want more detailed information about posture exposure.

- **Keywords:** Task-based analysis; Event-based analysis; Work-related musculoskeletal disorders

D. Kang; J. -H. Woo; Y. -C. Shin. Distribution and determinants of maximal physical work capacity of Korean male metal workers. S. 2137 – 2147.

The distribution of maximal physical work capacity (MPWC) can be used to establish an upper limit for energy expenditure during work (EEwork). If physically demanding work

has wearing effects, there will be a negative relationship between MPWC and workload. This study was conducted to investigate the distribution of MPWC among Korean metal workers and to examine the relationship between workload and MPWC. MPWC was estimated with a bicycle ergometer using a submaximal test. Energy expenditure was estimated by measuring heart rates during work. The study subjects were 507 male employees from several metal industries in Korea. They had a lower absolute VO_{2max} than the Caucasian populations described in previous studies. The older workers had a lower physical capacity and a greater overload at work. A negative relationship was found between MPWC and workload across all age groups. Upper limits for EEwork for all age groups and for older age groups are recommended based on the 5th percentile value of MPWC.

- **Keywords:** Maximal physical work capacity; Workload; Work energy expenditure limit

D. H. K. Chow; K. T. Y. Leung; A. D. Holmes. *Changes in spinal curvature and proprioception of schoolboys carrying different weights of backpack.* S. 2148 – 2156.

Despite evidence linking backpack carriage and back pain, previous studies to examine the effects of backpack carriage have focused on changes in physical performance rather than the direct effects on the spine itself. Spinal curvature and proprioception (in terms of spinal repositioning consistency) of 15 schoolboys during normal upright stance without a backpack and while carrying a specially adapted backpack loaded at 10, 15 and 20% of their bodyweight were measured and compared using repeated measures ANOVA. A significant flattening of the lumbar lordosis and the upper thoracic kyphosis was found with increasing backpack load, as well as a significant decrease in the thoracolumbar and lumbar repositioning consistencies. Carriage of a loaded backpack causes immediate changes in spinal curvature and appears to have a direct effect on the repositioning consistency. Further investigation of the changes in spinal curvature and repositioning consistency over time with prolonged backpack carriage is warranted. Daily carriage of a school backpack on the musculoskeletal health of children and adolescents has become an area of concern due to the association between backpack carriage and back pain. Data regarding the direct effect of backpack carriage on the spine in children are limited.

- **Keywords:** Load Carriage; Biomechanics; Spine curvature; Repositioning; Children

G. A. Mawston; P. J. McNair; M. G. Boocock. *The effects of prior warning and lifting-induced fatigue on trunk muscle and postural responses to sudden loading during manual handling.* S. 2157 – 2170.

This study investigated the effects of warning and lifting-induced fatigue on trunk muscle activity and postural responses to sudden loading. Thirty-one male subjects were subjected to sudden loading of a hand-held box with and without prior warning, before and after either lifting-induced fatigue or light callisthenic exercises. Results showed that warning did not alter the level of trunk muscle activity prior to sudden loading. Following warning, there was a reduction in all muscle and joint onset latencies and the magnitude of hip and knee flexion. Although fatigue did not influence muscle and joint initiation, it did negate the effects that warning had on reducing joint displacement. These findings indicate that warning prior to sudden loading may enhance postural responses, reduce ranges of joint motion and increase stability. However, the benefits of prior warning for reducing ranges of joint motion may not be present when a person is fatigued. Sudden unexpected loading and fatigue arising from manual handling practices in the workplace have been identified as contributing factors to the risk of low back injury. Findings from

this study provide information that is important for the design of interventions intended to reduce the incidence of manual handling-related back injuries.

- **Keywords:** Sudden loading; Warning; Fatigue; Postural responses; Lumbar spine; Electromyography

I. Cikajlo; Z. Matjačić. *The influence of boot stiffness on gait kinematics and kinetics during stance phase.* S. 2171 – 2182.

In the study, the influence of different boot prototype stiffness on gait kinematics and kinetics was investigated. The boot stiffness was determined by force-deformation measurement while pressing the foot model inserted into the boot by a custom-made robot. Gait analysis was carried out in nine neurologically intact subjects during walking while wearing two different boots with and without carrying a backpack, and differences were statistically tested using ANOVA. The results indicated distinctions in the boot shaft and vamp stiffness. The boot with a softer boot shaft enabled a wider range of motion in the ankle joint leading to more power generation in the ankle joint during the push-off, increased step length and gait velocity. The backpack mostly influenced the pelvis and trunk kinematics. The study has demonstrated the influence of boot shaft stiffness on biomechanical gait parameters and its importance for push-off that manufacturers should take into consideration when optimizing the footwear performance.

- **Keywords:** Footwear stiffness; Gait; Kinematics; Kinetics; Stance phase