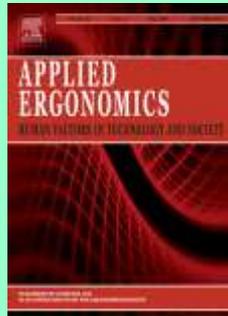


## **Applied Ergonomics - rok 2013, ročník 44**

### **Číslo 5 (September 2013)**



**Halimahtun M. Khalid, Martin G. Helander, Nilwan A. Hood. *Visualizing disaster attitudes resulting from terrorist activities.* Pages 671-679.**

The purpose of this study was to analyze people's attitudes to disasters by investigating how people feel, behave and think during disasters. We focused on disasters induced by humans, such as terrorist attacks. Two types of textual information were collected – from Internet blogs and from research papers. The analysis enabled forecasting of attitudes for the design of proactive disaster advisory scheme. Text was analyzed using a text mining tool, Leximancer. The outcome of this analysis revealed core themes and concepts in the text concerning people's attitudes. The themes and concepts were sorted into three broad categories: Affect, Behaviour, and Cognition (ABC), and the data was visualized in semantic maps. The maps reveal several knowledge pathways of ABC for developing attitudinal ontologies, which describe the relations between affect, behaviour and cognition, and the sequence in which they develop. Clearly, terrorist attacks induced trauma and people became highly vulnerable.

- **Keywords:** Disaster; Terrorism; Human factors

**V. Alan Spiker, Joan H. Johnston. *Assessing Counter-Terrorism field training with multiple behavioral measures.* Pages 680-686.**

Development of behavioral pattern recognition and analysis skills is an essential element of Counter-Terrorism training, particularly in the field. Three classes of behavioral measures were collected in an assessment of skill acquisition during a US Joint Forces Command-sponsored course consisting of Combat Tracking and Combat Profiling segments. Measures included situational judgment tests, structured behavioral observation checklists, and qualitative assessments of the emergence of specific knowledge–skills–attitudes over the course of the training. The paper describes statistical evidence across the three types of measures that indicate that behavioral pattern recognition and analysis skills were successfully acquired by most students (a mix of Army and civilian law enforcement personnel) during the field training exercises. Implications for broader training of these critical skills are also discussed.

- **Keywords:** Situational judgment tests; Behavioral observations; Scenarios; Knowledge–skills–attitudes; Profiling; Tracking

**Glyn Lawson, Alex W. Stedmon, Ke Zhang, Dawn L. Eubanks, Lara A. Frumkin. *The effects of self-awareness on body movement indicators of the intention to deceive.* Pages 687-693.**

A study was conducted to investigate the body movements of participants waiting to be interviewed in one of two conditions: preparing to answer questions truthfully or preparing to lie. The effects of increased self-awareness were also investigated, with half of the participants facing a mirror; the other half facing a blank wall. Analysis of covertly obtained video footage showed a significant interaction for the duration of hand/arm movements between deception level and self-awareness. Without a mirror, participants expecting to lie spent less time moving their hands than those expecting to tell the truth; the opposite was seen in the presence of a mirror. Participants expecting to lie also had higher levels of anxiety and thought that they were left waiting for less time than those expecting to tell the truth. These findings led to the identification of further research areas with the potential to support deception detection in security applications.

- **Keywords:** Deception; Self-awareness

**Christin Kirchhübel, David M. Howard. *Detecting suspicious behaviour using speech: Acoustic correlates of deceptive speech – An exploratory investigation.* Pages 694-702.**

The current work intended to enhance our knowledge of changes or lack of changes in the speech signal when people were being deceptive. In particular, the study attempted to investigate the appropriateness of using speech cues in detecting deception. Truthful, deceptive and control speech were elicited from ten speakers in an interview setting. The data were subjected to acoustic analysis and results are presented on a range of speech parameters including fundamental frequency ( $f_0$ ), overall amplitude and mean vowel formants  $F_1$ ,  $F_2$  and  $F_3$ . A significant correlation could not be established between deceptiveness/truthfulness and any of the acoustic features examined. Directions for future work are highlighted.

- **Keywords:** Deception; Speech acoustics; Fundamental frequency; Formant frequency

**Peter Eachus, Alex Stedmon, Les Baillie. *Hostile intent in public crowded spaces: A field study.* Pages 703-709.**

Hostile reconnaissance is vital to successful terrorist activity. Individuals carrying out this activity are likely to experience raised levels of stress and this will manifest itself at biological, physiological, psychological and behavioural levels, providing an opportunity for detection. A field trial was undertaken in an ecologically valid environment measuring variables considered likely to be salient during hostile intent. The parameters examined in the field trial varied in a predictable manner and suggest that stressed individuals secrete a volatile steroid based marker that could form the basis for remote detection. Thus, overall the findings of this research provide a validated model of hostile intent that can be used by other researchers to test interventions aimed at detecting or deterring hostile intent.

- **Keywords:** Hostile reconnaissance; Terrorism; Detection; Deception; Pheromones

**Jolie M. Martin, Ion Juvina, Christian Lebiere, Cleotilde Gonzalez. *The effects of individual and context on aggression in repeated social interaction.* Pages 710-718.**

In two studies using variations of the Prisoner's Dilemma game, we explore the impact of individual traits and social context on aggressive behavior. In the first study, we compared defection rates in the Iterated Prisoner's Dilemma when participants were presented with a payoff matrix (Description condition) or learned payoffs through experience (Experience condition). Interpersonal trust and maximizing tendency led to relatively less defection in the Description condition than in the Experience condition, demonstrating that individual characteristics manifest differently depending on the information available to decision-makers. In the second study, we employed a new game paradigm, the Intergroup Prisoner's Dilemma with Intragroup Power Dynamics, to examine the way that power motives influence extreme aggressive behavior. We discovered that certain individuals exhibit very high levels of defection, but only when they play with particular combinations of predefined strategies, further suggesting how the confluence of individual factors and context can induce aggression.

- **Keywords:** Aggression; Extremism; Game theory; Individual differences; Power; Prisoner's Dilemma; Social context

**Paul H.P. Yeow, Y.Y. Yuen, W.H. Loo. *Ergonomics issues in national identity card for homeland security.* Pages 719-729.**

Ever since the 9/11 terrorist attack, many countries are considering the use of smart national identity card (SNIC) which has the ability to identify terrorists due to its biometric verification function. However, there are many ergonomics issues in the use of SNIC, e.g. card credibility. This research presents a case study survey of Malaysian users. Although most citizens (>96%) own MyKad (Malaysia SNIC), many do not carry it around and use its applications. This defeats one of its main purposes, i.e. combating terrorism. Thus, the research investigates ergonomics issues affecting the citizens' Intention to Use (ITU) MyKad for homeland security by using an extended technology acceptance model. Five hundred questionnaires were collected and analysed using structural equation modelling. Results show that perceived credibility and performance expectancy are the key issues. The findings provide many countries with insights into methods of addressing ergonomics issues and increasing adoption of SNIC for homeland security.

- **Keywords:** National identity card; Terrorism; User acceptance

**N. Dadashi, A.W. Stedmon, T.P. Pridmore. *Semi-automated CCTV surveillance: The effects of system confidence, system accuracy and task complexity on operator vigilance, reliance and workload.* Pages 730-738.**

Recent advances in computer vision technology have lead to the development of various automatic surveillance systems, however their effectiveness is adversely affected by many factors and they are not completely reliable. This study investigated the potential of a semi-automated surveillance system to reduce CCTV operator workload in both detection and tracking activities. A further focus of interest was the degree of user reliance on the automated system. A simulated prototype was developed which mimicked an automated system that provided different levels of system confidence information. Dependent variable measures were taken for secondary task performance, reliance and subjective workload. When the automatic component of a semi-automatic CCTV surveillance system provided reliable system confidence information to operators, workload significantly decreased and spare mental capacity significantly increased. Providing feedback about system confidence and accuracy appears to be one important

way of making the status of the automated component of the surveillance system more 'visible' to users and hence more effective to use.

- **Keywords:** Semi-automated surveillance; CCTV; Detection; Tracking; Security

**Michael Kenney, John Horgan, Cale Horne, Peter Vining, Kathleen M. Carley, Michael W. Bigrigg, Mia Bloom, Kurt Braddock. *Organisational adaptation in an activist network: Social networks, leadership, and change in al-Muhajiroun. Pages 739-747.***

Social networks are said to facilitate learning and adaptation by providing the connections through which network nodes (or agents) share information and experience. Yet, our understanding of how this process unfolds in real-world networks remains underdeveloped. This paper explores this gap through a case study of al-Muhajiroun, an activist network that continues to call for the establishment of an Islamic state in Britain despite being formally outlawed by British authorities. Drawing on organisation theory and social network analysis, we formulate three hypotheses regarding the learning capacity and social network properties of al-Muhajiroun (AM) and its successor groups. We then test these hypotheses using mixed methods. Our methods combine quantitative analysis of three agent-based networks in AM measured for structural properties that facilitate learning, including connectedness, betweenness centrality and eigenvector centrality, with qualitative analysis of interviews with AM activists focusing on organisational adaptation and learning. The results of these analyses confirm that al-Muhajiroun activists respond to government pressure by changing their operations, including creating new platforms under different names and adjusting leadership roles among movement veterans to accommodate their spiritual leader's unwelcome exodus to Lebanon. Simple as they are effective, these adaptations have allowed al-Muhajiroun and its successor groups to continue their activism in an increasingly hostile environment.

- **Keywords:** Al-Muhajiroun; Islamist militancy; Organisational adaptation; Social network analysis; Learning; ORA; AutoMap

**J.S. Boschman, H.F. van der Molen, J.K. Sluiter, M.H.W. Frings-Dresen. *Psychosocial work environment and mental health among construction workers. Pages 748-755.***

We assessed psychosocial work environment, the prevalence of mental health complaints and the association between these two among bricklayers and construction supervisors. For this cross-sectional study a total of 1500 bricklayers and supervisors were selected. Psychosocial work characteristics were measured using the Dutch Questionnaire on the Experience and Evaluation of Work and compared to the general Dutch working population. Mental health effects were measured with scales to assess fatigue during work, need for recovery after work, symptoms of distress, depression and post-traumatic stress disorder. The prevalence of self-reported mental health complaints was determined using the cut-off values. Associations between psychosocial work characteristics and self-reported mental health complaints were analysed using logistic regression.

Total response rate was 43%. Compared to the general working population, bricklayers experienced statistically significant worse job control, learning opportunities and future perspectives; supervisors experienced statistically significant higher psychological demands and need for recovery. Prevalence of self-reported mental health effects among bricklayers and supervisors, respectively, were as follows: high need for recovery after work (14%; 25%), distress (5%, 7%), depression (18%, 20%) and post-traumatic stress disorder (11%, 7%). Among both occupations, high work speed and quantity were associated with symptoms of depression. Further, among construction supervisors, low

participation in decision making and low social support of the direct supervisor was associated with symptoms of depression.

The findings in the present study indicate psychosocial risk factors for bricklayers and supervisors. In each occupation a considerable proportion of workers was positively screened for symptoms of common mental disorders.

- **Keywords:** Construction industry; Work environment; Psychosocial factors; Common mental disorders

**Makoto Itoh, Tatsuya Horikome, Toshiyuki Inagaki. *Effectiveness and driver acceptance of a semi-autonomous forward obstacle collision avoidance system.* Pages 756-763.**

This paper proposes a semi-autonomous collision avoidance system for the prevention of collisions between vehicles and pedestrians and objects on a road. The system is designed to be compatible with the human-centered automation principle, i.e., the decision to perform a maneuver to avoid a collision is made by the driver. However, the system is partly autonomous in that it turns the steering wheel independently when the driver only applies the brake, indicating his or her intent to avoid the obstacle. With a medium-fidelity driving simulator, we conducted an experiment to investigate the effectiveness of this system for improving safety in emergency situations, as well as its acceptance by drivers. The results indicate that the system effectively improves safety in emergency situations, and the semi-autonomous characteristic of the system was found to be acceptable to drivers.

- **Keywords:** Advanced driver assistance systems; Adaptive automation; Collision avoidance

**Gemma J.M. Read, Paul M. Salmon, Michael G. Lenné. *Sounding the warning bells: The need for a systems approach to understanding behaviour at rail level crossings.* Pages 764-774.**

Collisions at rail level crossings are an international safety concern and have been the subject of considerable research effort. Modern human factors practice advocates a systems approach to investigating safety issues in complex systems. This paper describes the results of a structured review of the level crossing literature to determine the extent to which a systems approach has been applied. The measures used to determine if previous research was underpinned by a systems approach were: the type of analysis method utilised, the number of component relationships considered, the number of user groups considered, the number of system levels considered and the type of model described in the research. None of research reviewed was found to be consistent with a systems approach. It is recommended that further research utilise a systems approach to the study of the level crossing system to enable the identification of effective design improvements.

- **Keywords:** Rail level crossings; Systems approach; Systems theory

**Ziqing Zhuang, Chang Shu, Pengcheng Xi, Michael Bergman, Michael Joseph. *Head-and-face shape variations of U.S. civilian workers.* Pages 775-784.**

The objective of this study was to quantify head-and-face shape variations of U.S. civilian workers using modern methods of shape analysis. The purpose of this study was based on previously highlighted changes in U.S. civilian worker head-and-face shape over the last few decades – touting the need for new and better fitting respirators – as well as the study's usefulness in designing more effective personal protective equipment (PPE) –

specifically in the field of respirator design. The raw scan three-dimensional (3D) data for 1169 subjects were parameterized using geometry processing techniques. This process allowed the individual scans to be put in correspondence with each other in such a way that statistical shape analysis could be performed on a dense set of 3D points. This process also cleaned up the original scan data such that the noise was reduced and holes were filled in. The next step, statistical analysis of the variability of the head-and-face shape in the 3D database, was conducted using Principal Component Analysis (PCA) techniques. Through these analyses, it was shown that the space of the head-and-face shape was spanned by a small number of basis vectors. Less than 50 components explained more than 90% of the variability. Furthermore, the main mode of variations could be visualized through animating the shape changes along the PCA axes with computer software in executable form for Windows XP. The results from this study in turn could feed back into respirator design to achieve safer, more efficient product style and sizing. Future study is needed to determine the overall utility of the point cloud-based approach for the quantification of facial morphology variation and its relationship to respirator performance.

- **Keywords:** Anthropometric; 3D scan; Head-and-face modeling; Shape analysis; Respirator design

**Erja Sormunen, Nina Nevala. *User-oriented evaluation of mechanical single-channel axial pipettes.* Pages 785-791.**

Hand tools should be designed so that they are comfortable to use, fit the hand and are user-oriented. Six different manual, single-channel axial pipettes were evaluated for such objective outcomes as muscular activity, wrist postures and efficiency, as well as for subjective outcomes concerning self-assessed features of pipette usability and musculoskeletal strain. Ten experienced laboratory employees volunteered for the study. The results showed that light and short pipettes with better tool comfort resulted in reduced muscular activity and perceived musculoskeletal strain when they were compared with a long and heavy pipette. There were no differences in the efficiency between the different pipettes. Combining both the objective and subjective measures enabled a broader evaluation of product usability. The results of this study can be used both in product development and as information on which to base the purchase of new pipettes for laboratory work.

- **Keywords:** Hand tool; Ergonomics; Laboratory work

**Yasuyo Sunaga, Masaya Anan, Koichi Shinkoda. *Biomechanics of rising from a chair and walking in pregnant women.* Pages 792-798.**

The present study aimed to assess the changes in the pattern of rising from a chair and walking forward as pregnancy progressed. Twelve pregnant women and 10 nulliparous women were included in this study. Participants were videotaped with a digital video camera in the sagittal plane, and the coordinates of the markers attached to the subjects were identified using image analysis software. The peak trunk-flexion angle in pregnant women during rising was smaller, but the hip-extension angle during the stance phase was larger than in controls. Also, the peak horizontal and vertical velocities of the center of mass were lower, and appeared earlier, in pregnant women than in controls. During rising, pregnant women dampened the propulsion attributable to increased uterus volume, and they enhanced the forward propulsion at gait initiation. To ensure safe motion, pregnant women should not initiate gait until reaching a stable standing position after rising.

- **Keywords:** Pregnant women; Rising; Walking

**Alexandra R. Lang, Jennifer L. Martin, Sarah Sharples, John A. Crowe. *The effect of design on the usability and real world effectiveness of medical devices: A case study with adolescent users. Pages 799-810.***

Adolescents are currently overlooked in many fields of healthcare research and as a result are often required to use medical devices that have been designed for use by either children or adults. This can lead to poor adherence and a reduction in health outcomes.

This study examines the role of device design in the real-world effectiveness of a medical device used in the treatment of cystic fibrosis from the perspective of adolescent users. Interactive design interviews were carried out with 20 adolescent users of the acapella® physiotherapy device to investigate user requirements and themes about the user-device relationship that are important to this user group. This study found that adolescent users of the acapella® device do not use the device as regularly and correctly as is recommended by clinicians. A number of aspects of the current design of the acapella® device were identified that affect how and how often it is used. Five factors are identified that may improve the real world effectiveness of the acapella® device for adolescents with Cystic Fibrosis: engagement, information, confidence, aesthetics and compatibility with lifestyle.

- **Keywords:** Adolescents; User requirements; Medical devices; Usability; Effectiveness

**Tarcisio Abreu Saurin, Santiago Sosa Gonzalez. *Assessing the compatibility of the management of standardized procedures with the complexity of a sociotechnical system: Case study of a control room in an oil refinery. Pages 811-823.***

Although the need for the management of complex socio-technical systems (STS) to be compatible with the nature of those systems is widely recognized, there are few guidelines on how to determine the actual extent of this compatibility. The purpose of this study is to assess how compatible the management of standardized procedures (SPs) is with the nature of a complex STS. To this end, a case study was made of a control room in an oil refinery, involving the following stages: (a) delimitation of the investigated STS; (b) description of the STS according to a set of characteristics of complex STS; (c) application of two types of questionnaires to thirty workers – one of them to assess their perceptions about the applicability of seven principles of SPs management in complex STS and the other to determine their perceptions about the actual use of these principles; and (d) a feedback meeting with workers to discuss the results of the assessment. The assessment is discussed in terms of its limitations, usefulness and ease of use of the data collection and analysis tools.

- **Keywords:** Standardized procedures; Complexity; Sociotechnical systems; Control rooms

**Steven A. Lavender, Jay P. Mehta, W. Gary Allread. *Comparisons of tibial accelerations when walking on a wood composite vs. a concrete mezzanine surface. Pages 824-827.***

Mezzanine surfaces can be made from concrete, bar grate, or composite materials. Anecdotal data indicate that mezzanines in distribution centers made from composite materials, due to their increased compliance, may be a more comfortable working surface. Prior research suggested that a measure of tibial shock, peak tibial acceleration, could potentially discriminate the biomechanical differences between these surfaces. The objective of this study was to quantify differences in tibial accelerations as 27 people

walked on mezzanines constructed from concrete and a wood composite material. Accelerometers were attached bilaterally to the shins of volunteers, and data were collected as they walked 30.5 m on each surface at their normal walking speed, a faster-than-normal walking speed, and a slower-than-normal walking speed. Peak acceleration values obtained from the leg with the highest values were compared. On average, the peak acceleration values were 5% higher on the concrete mezzanine as compared with the wood composite mezzanine ( $p = .036$ ). These findings suggest that individuals working on mezzanines in distribution centers constructed from composite surfaces would potentially experience less discomfort associated with long exposure periods on these surfaces.

- **Keywords:** Musculoskeletal disorders; Distribution centers; Gait; Tibial shock; Knee pain

**Pieter Coenen, Idsart Kingma, Cécile R.L. Boot, Paulien M. Bongers, Jaap H. van Dieën. *Inter-rater reliability of a video-analysis method measuring low-back load in a field situation. Pages 828-834.***

Valid and reliable low-back load assessment tools that can be used in field situations are needed for epidemiologic studies and for ergonomic practice. The aim of this study was to assess the inter-rater reliability of a low-back load video-analysis method in a field setting.

Five raters analyzed 50 work site manual material handling tasks of 14 workers. Peak and mean moments at the level of L5/S1, and segment angles were obtained using the video-analysis method. Intra-class correlation coefficients (ICCs) and median standard deviations across raters were calculated.

ICCs revealed excellent inter-rater reliability ( $>0.9$ ) for peak and mean moments, ICCs of segment angles were variable. Median standard deviations showed relatively small inter-rater variance for moments (standard deviation  $<10$  Nm) and segment angle variation ranging from  $0^\circ$  to  $20^\circ$ . The proposed video-analysis method, provides a reliable tool for obtaining low-back loads from occupational field tasks.

- **Keywords:** Low-back loading; Lifting; Low-back pain; Video-analysis; Inter-rater reliability

**Elisabet Borg, Gunnar Borg. *A demonstration of level-anchored ratio scaling for prediction of grip strength. Pages 835-840.***

Level-anchored ratio scaling, such as the Borg CR10 scale<sup>®</sup> and the Borg CR100 scale<sup>®</sup>, uses verbal anchors in congruence with numbers to give ratio data together with natural levels of intensity. This presupposes that the anchors possess natural positions in the subjective dynamic range and also "numerical" inter-relations. In an experiment, subjects had to produce a force of handgrip corresponding to their conception of "Strong", followed by a "Maximal" performance. By using the previously found relationship between "Strong" and "Maximal" of 1:2 together with knowledge of the exponent in the power S-R-function ( $R = c \times S^n$ ) for grip strength,  $n = 1.8$ , predictions of individual maximal performances were obtained. The predicted values correlated 0.76 with, and deviated only 3% (ns) from, actual maximal performances of grip strength. This result –as previously also found for aerobic capacity–gives a strong support for the use of verbal anchors, so common in category scaling, also in "ratio scaling" and that the Borg CR-scales fulfill the requirements for ratio scales. For estimation of muscular strength, such as grip strength, this present study points to the value of using submaximal determinations as a complement to maximal performances (e.g., to obtain measures of functional capacity). The results also support the increasingly common use

of the CR-methodology in other ergonomic settings concerning suitable design of tools and equipment.

- **Keywords:** Borg CR scales; Grip strength; Functional capacity; Verbal anchors

**Ashish D. Nimbarte, Yun Sun, Majid Jaridi, Hongwei Hsiao.**  
***Biomechanical loading of the shoulder complex and lumbosacral joints during dynamic cart pushing task. Pages 841-849.***

The primary objective of this study was to quantify the effect of dynamic cart pushing exertions on the biomechanical loading of shoulder and low back. Ten participants performed cart pushing tasks on flat (0°), 5°, and 10° ramped walkways at 20 kg, 30 kg, and 40 kg weight conditions. An optoelectronic motion capturing system configured with two force plates was used for the kinematic and ground reaction force data collection. The experimental data was modeled using AnyBody modeling system to compute three-dimensional peak reaction forces at the shoulder complex (sternoclavicular, acromioclavicular, and glenohumeral) and low back (lumbosacral) joints. The main effect of walkway gradient and cart weight, and gradient by weight interaction on the biomechanical loading of shoulder complex and low back joints was statistically significant (all  $p < 0.001$ ). At the lumbosacral joint, negligible loading in the mediolateral direction was observed compared to the anteroposterior and compression directions. Among the shoulder complex joints, the peak reaction forces at the acromioclavicular and glenohumeral joints were comparable and much higher than the sternoclavicular joint. Increased shear loading of the lumbosacral joint, distraction loading of glenohumeral joint and inferosuperior loading of the acromioclavicular joint may contribute to the risk of work-related low back and shoulder musculoskeletal disorder with prolonged and repetitive use of carts.

- **Keywords:** Cart; Pushing; Shoulder; Low back; Biomechanical loading