



Anirban Chowdhury, J. Sanjog, Swathi Matta Reddy & Sougata Karmakar. *Nanomaterials in the field of design ergonomics: present status.* Pages 1453-1462.

Application of nanotechnology and nanomaterials is not new in the field of design, but a recent trend of extensive use of nanomaterials in product and/or workplace design is drawing attention of design researchers all over the world. In the present paper, an attempt has been made to describe the diverse use of nanomaterials in product and workplace design with special emphasis on ergonomics (occupational health and safety; thermo-regulation and work efficiency, cognitive interface design; maintenance of workplace, etc.) to popularise the new discipline 'nanoergonomics' among designers, design users and design researchers. Nanoergonomics for sustainable product and workplace design by minimising occupational health risks has been felt by the authors to be an emerging research area in coming years.

Practitioner Summary: Use of nanomaterials in the field of design ergonomics is less explored till date. In the present review, an attempt has been made to extend general awareness among ergonomists/designers about applications of nanomaterials/nanotechnology in the field of design ergonomics and about health implications of nanomaterials during their use.

- Keywords: workplace design, building and construction ergonomics, environmental ergonomics, health and safety, product safety

Achim Elfering, Simone Grebner & Martina Haller. *Railway-controller-perceived mental work load, cognitive failure and risky commuting.* Pages 1463-1475.

This questionnaire study tests cognitive failures as a mediator of the potential influence of mental work demands and conscientiousness on risky commuting. Participants were 104 railway-controllers (19% female). Failure of memory, attention regulation and action execution were assessed with the Workplace Cognitive Failure (WCF) scale. Mental work demands were measured by the Instrument for Stress-Oriented Task Analysis (ISTA). A structural equation model testing WCF as the mediator of (1) the relationship between mental work demands and risky commuting ($p < 0.05$) and (2) the link between conscientiousness and risky commuting ($p < 0.05$) fitted well with empirical data. In railway-controllers frequent interruptions, time pressure, and high concentration demands are likely to increase cognitive load and thereby boost WCF during work and

also during commuting, thereby reducing commuting safety. The results underline the need for work redesign to improve commuting safety.

Practitioner Summary: Commuting accidents occur frequently and at high cost. This study shows that mental work demands of railway staff are related to cognitive failure and risky commuting behaviour such as failing to give way and overlooking stop signs. Primary prevention of commuting accidents should include reduction of mental workload.

- **Keywords:** occupational stress, commuting safety, cognitive failure

Nicholas D. Cottrell & Benjamin K. Barton. *The impact of artificial vehicle sounds for pedestrians on driver stress.* Pages 1476-1486.

Electrically based vehicles have produced some concern over their lack of sound, but the impact of artificial sounds now being implemented have not been examined in respect to their effects upon the driver. The impact of two different implementations of vehicle sound on driver stress in electric vehicles was examined. A Nissan HEV running in electric vehicle mode was driven by participants in an area of congestion using three sound implementations: (1) no artificial sounds, (2) manually engaged sounds and (3) automatically engaged sounds. Physiological and self-report questionnaire measures were collected to determine stress and acceptance of the automated sound protocol. Driver stress was significantly higher in the manually activated warning condition, compared to both no artificial sounds and automatically engaged sounds. Implications for automation usage and measurement methods are discussed and future research directions suggested.

Practitioner Summary: The advent of hybrid- and all-electric vehicles has created a need for artificial warning signals for pedestrian safety that place task demands on drivers. We investigated drivers' stress differences in response to varying conditions of warning signals for pedestrians. Driver stress was lower when noises were automated.

- **Keywords:** stress, automation, vehicle noise, driving task, task demand

Karen E. Raymer, Johan Bergström & James M. Nyce. Anaesthesia monitor alarms: a theory-driven approach. Pages 1487-1501.

The development of physiologic monitors has contributed to the decline in morbidity and mortality in patients undergoing anaesthesia. Diverse factors (physiologic, technical, historical and medico-legal) create challenges for monitor alarm designers. Indeed, a growing body of literature suggests that alarms function sub-optimally in supporting the human operator. Despite existing technology that could allow more appropriate design, most anaesthesia alarms still operate on simple, pre-set thresholds. Arguing that more alarms do not necessarily make for safer alarms is difficult in a litigious medico-legal environment and a competitive marketplace. The resultant commitment to the status quo exposes the risks that a lack of an evidence-based theoretical framework for anaesthesia alarm design presents. In this review, two specific theoretical foundations with relevance to anaesthesia alarms are summarised. The potential significance that signal detection theory and cognitive systems engineering could have in improving anaesthesia alarm design is outlined and future research directions are suggested.

Practitioner Summary: The development of physiologic monitors has increased safety for patients undergoing anaesthesia. Evidence suggests that the full potential of the alarms embedded within those monitors is not being realised. In this review article, the authors propose a theoretical framework that could lead to the development of more ergonomic anaesthesia alarms.

- **Keywords:** alarms and warnings, advanced human-machine interfaces, anaesthesia alarms, anaesthesia equipment, equipment design, monitoring, patient safety, socio-technical systems

Po-Hung Lin & Patrick Patterson. *Investigation of perceived image quality and colourfulness in mobile displays for different cultures, ambient illumination, and resolution.* Pages 1502-1512.

This study explored the effects of culture, ambient illumination, and resolution on perceived image quality and colourfulness of mobile displays. Thirty Taiwanese and 30 American students participated in the experiment. Two types of culture (Taiwanese and American), two types of illumination level (1500 lux and 7000 lux), and five types of resolution level (320×240, 260×208, 200×160, 140×112, and 80×64) were investigated in the experiment. Interactions between culture and resolution, and between illumination and resolution, were found for both perceived image quality and colourfulness. The results indicated that subjects were able to detect smaller differences in perceived image quality but not for colourfulness, and Taiwanese subjects could detect smaller differences than could the American subjects for both perceived image quality and colourfulness. The results further indicated that Taiwanese subjects were able to detect smaller differences at most of the resolution levels for colourfulness in 1500 lux than were the American subjects.

Practitioner Summary: This study found, from culture differences and ergonomics considerations, that Taiwanese subjects could detect smaller differences than could American subjects when evaluating perceived image quality and colourfulness on mobile displays. Mobile display manufacturers can use the results of this study as a reference for future mobile display design.

- **Keywords:** culture, ambient illumination, resolution, image quality, colourfulness

Errol R. Hoffmann & Alan H.S. Chan. *Underwater movement times with ongoing visual control.* Pages 1513-1523.

Arm movements made in a water environment take longer to perform than in an air environment due to the drag forces experienced by the arm. Movement times for ballistic underwater movements have been accurately modelled by Hoffmann and Gan (1988)**16**. Hoffmann, E.R. and Gan, K-C. 1988. Underwater ballistic movements. *Ergonomics*, 31 (9): 1305 - 1316.

View all references). The present work models the movement time for movements that require ongoing visual control. In these movements, the 'distance-covering' phase is carried out at high speeds and will be affected by the fluid characteristics, while the 'homing-in' phase, where speeds are low, is less affected. An experiment is reported that models these effects and which indicates that a ballistic component needs to be added to the standard Fitts model in order to account for the drag forces in the distance-covering phase of the movement.

Practitioner Summary: Many tasks, such as maintenance and salvage work, require work to be done underwater. Times for performing underwater tasks are generally longer than on land. This article is one step in modelling the difference in task times for land and underwater movements.

- **Keywords:** underwater movements, visually-controlled moves, Fitts' law

Julien Lardy, Georges Beurier & Xuguang Wang. *Effects of rotation amplitude on arm movement when rotating a spherical object. Pages 1524-1534.*

Arm movements when rotating a spherical object were experimentally investigated. Twelve volunteers participated in the experiment and were asked to rotate a sphere for a large range of amplitude. Results showed that subjects anticipated their posture at the beginning of object manipulation even for low rotation amplitudes. The way of anticipation strongly depended on rotation direction. The end-state comfort hypothesis, effects of joint limits and principle of minimum work were examined for explaining motion control. The anticipation would ensure a better end-state comfort while avoiding joint limits in case of higher amplitude of object rotation. Meanwhile, it should not deteriorate the comfort at the beginning of manipulation too much. High postural variability for low rotation amplitude tasks suggested that there might exist a range of postures of similar level of comfort. These findings will be useful in developing human behaviour-based motion simulations for digital human.

Practitioner Summary: Arm movement was investigated when rotating a spherical object with a large range of amplitude. The end-state comfort hypothesis, effects of joint limits and principle of minimum work were examined for explaining motion control. Results will be helpful for a better design of rotary controls and for developing motion simulation algorithms.

- **Keywords:** arm movement, object manipulation, hand orientation control, joint limits

Jungyong Lee & Maury A. Nussbaum. *Experienced workers exhibit distinct torso kinematics/kinetics and patterns of task dependency during repetitive lifts and lowers. Pages 1535-1547.*

Individual differences in work methods may be related to the risk of injury during manual material handling tasks, yet existing evidence comparing experienced workers and novices is mixed. This study assessed torso kinematics and kinetics among six experienced workers and six novices during repetitive lifts/lowers under different task configurations (symmetric vs. asymmetric and lift vs. lower). Several important potential confounding effects were controlled. Peak kinematic and kinetic measures were typically higher among experienced workers and suggestive of exposure to higher levels of low back injury risk, though overall exposure levels were moderate. Work methods used by experienced workers were modified between task conditions, whereas novice behaviours were more consistent. Control of torso kinematics/kinetics may thus not be a primary factor in determining experienced worker's work methods, and future investigation is needed to establish if, or under what conditions, these methods are protective and/or should be the basis for interventions including training.

Practitioner Summary: Whether lifting experience reduces low back injury risk is unclear from earlier findings. Results from a controlled experiment suggest that lifting experience may not be associated consistently with reduced physical demands or injury risk. Further investigation is needed to assess the utility of training based on the methods of experienced workers.

- **Keywords:** experience, low back, asymmetry, lifting, lowering, biomechanics

David M. Andrews, Kryisia M. Fiedler, Patricia L. Weir & Jack P. Callaghan. *The effect of posture category salience on decision times and errors*

when using observation-based posture assessment methods. Pages 1548-1558.

Observation-based posture assessment methods (e.g. RULA, 3DMatch) require classification of body postures into categories. This study investigated the effect of improving posture category salience (adding borders, shading and colour to the posture categories) on posture selection error rates and decision times of novice analysts. Ninety university students with normal or corrected normal visual acuity and who were not colourblind, were instructed to select posture categories as quickly and accurately as possible, in five salience conditions (Plain (no border, no shading, no colour); Grey Border; Red Border; Grey Shading (GS) and Red Shading (RS)) for images presented in randomised blocks (240 classifications made by each participant) on a computer interface. Participants responded quickest in the Border conditions, classifying postures about 5% faster than in the Plain condition. Coloured diagrams significantly reduced posture classification errors by approximately 1.5%. Overall, the best performance, based on both error rate and decision time combined, resulted from incorporating a Grey Border to the posture category diagrams; a simple enhancement that could be made to most current observation-based posture assessment tools.

Practitioner Summary: The salience of posture diagrams used in observation-based posture assessment tools was evaluated with respect to analyst error rates and decision times. The best performance resulted from incorporating a grey border to the posture diagrams; a simple enhancement that can be made to most current observation-based posture assessment tools.

- **Keywords:** salience, visual search, postures categories, observation-based posture assessment methods, video

Erwin M. Speklé, Marco J.M. Hoozemans, Allard J. van der Beek, Birgitte M. Blatter & Jaap H. van Dieën. *The predictive validity of the RSI QuickScan questionnaire with respect to arm, shoulder and neck symptoms in computer workers.* Pages 1559-1570.

The aim of this study was to determine whether results from the RSI QuickScan questionnaire on risk factors for arm, shoulder and neck symptoms can predict future arm, neck and shoulder symptoms in a population of computer workers. For this prospective cohort study, with a follow-up of 24 months, 3383 workers who regularly worked with a computer were approached. Generalised estimating equations (GEE) with 6, 12, 18 and 24 months time lags were used to determine whether high exposure was related to symptoms at follow-up. The results showed that high scores on 9 out of 13 scales, including previous symptoms, were significantly related to arm, shoulder and neck symptoms at follow-up. These results provide support for the predictive validity of the RSI QuickScan questionnaire.

Practitioner Summary: The results showed that high scores on 9 out of 13 scales, including previous symptoms, were significantly related to arm, shoulder and neck symptoms at follow-up. The RSI QuickScan questionnaire may be recommended as a tool in the identification of computer workers who should be targeted with interventions aimed at prevention of future symptoms.

- **Keywords:** office ergonomics, ergonomics tools and methods, musculoskeletal disorders, upper limb disorders, risk assessment and management

Yafa Levanon, Amit Gefen, Yehuda Lerman, Uri Givon & Navah Z. Ratzon. *Reducing musculoskeletal disorders among computer operators:*

comparison between ergonomics interventions at the workplace. Pages 1571-1585.

Typing is associated with musculoskeletal disorders (MSDs) caused by multiple risk factors. This control study aimed to evaluate the efficacy of a workplace intervention for reducing MSDs among computer workers. Sixty-six subjects with and without MSD were assigned consecutively to one of three groups: ergonomics intervention (work site and body posture adjustments, muscle activity training and exercises) accompanied with biofeedback training, the same ergonomics intervention without biofeedback and a control group. Evaluation of MSDs, body posture, psychosocial status, upper extremity (UE) kinematics and muscle surface electromyography were carried out before and after the intervention in the workplace and the motion lab. Our main hypothesis that significant differences in the reduction of MSDs will exist between subjects in the study groups and controls was confirmed ($\chi^2 = 13.3$; $p = 0.001$). Significant changes were found in UE kinematics and posture as well. Both ergonomics interventions effectively reduced MSD and improved body posture.

Practitioner Summary: This study aimed to test the efficacy of an individual workplace intervention programme among computer workers by evaluating musculoskeletal disorders (MSDs), body posture, upper extremity kinematics, muscle activity and psychosocial factors were tested. The proposed ergonomics interventions effectively reduced MSDs and improved body posture.

- Keywords: work-related disorders, computer work, ergonomics intervention, upper extremity kinematics, muscle activity

Kieran O'Sullivan, Raymond McCarthy, Alison White, Leonard O'Sullivan & Wim Dankaerts. Lumbar posture and trunk muscle activation during a typing task when sitting on a novel dynamic ergonomic chair. Pages 1586-1595.

Low back pain (LBP) is a common musculoskeletal disorder and prolonged sitting often aggravates LBP. A novel dynamic ergonomic chair ('Back App'), which facilitates less hip flexion while sitting on an unstable base has been developed. This study compared lumbar posture and trunk muscle activation on this novel chair with a standard backless office chair. Twelve painfree participants completed a typing task on both chairs. Lumbar posture and trunk muscle activation were collected simultaneously and were analysed using paired t -tests. Sitting on the novel dynamic chair significantly ($p < 0.05$) reduced both lumbar flexion and the activation of one back muscle (Iliocostalis Lumborum pars Thoracis). The discomfort experienced was mild and was similar ($p > 0.05$) between chairs. Maintaining lordosis with less muscle activation during prolonged sitting could reduce the fatigue associated with upright sitting postures. Studies with longer sitting durations, and in people with LBP, are required.

Practitioner Summary: Sitting on a novel dynamic chair resulted in less lumbar flexion and less back muscle activation than sitting on a standard backless office chair during a typing task among pain-free participants. Facilitating lordotic sitting with less muscle activation may reduce the fatigue and discomfort often associated with lordotic sitting postures.

- **Keywords:** posture, back pain, ergonomics, lordosis, sitting

Julien Causse, Xuguang Wang & Lisa Denninger. *An experimental investigation on the requirement of roof height and sill width for car ingress and egress.* Pages 1596-1611.

This study aimed at experimentally investigating the influence of roof height and sill width on car ingress/egress movements. The first uncomfortable (*Ht1*) and the lowest acceptable (*Ht2*) roof heights were obtained from 26 participants of three different stature groups thanks to a multi-adjustable vehicle mock-up. Both *Ht1* and *Ht2* were affected neither by stature nor by vehicle type. Only a difference of 45 mm between *Ht1* and *Ht2* was observed. Tall volunteers more flexed the trunk and neck than short persons thanks to a larger space available around the seat when the head passing under the roof. The vehicle type had almost no effect on upper body posture. The roof height only affected neck flexion. The sill width mainly imposed a lateral translation. Results demonstrated that an appropriate roof height should be determined carefully. A small change of 45 mm in roof height may lead to an unacceptable situation.

Practitioner Summary: The present study experimentally investigated the effects of roof height and sill width on car ingress and egress movements. Short females required almost the same roof height as tall males due to smaller space around the seat. The results would help to optimise car dimensions for improving car accessibility.

- **Keywords:** ingress, egress, motion analysis, discomfort, digital human modelling

Dimitris Nathanael & Nicolas Marmaras. *A question of our marketing or our preconceptions: Commentary on the paper 'A strategy for human factors/ergonomics: developing the discipline and profession'.* Pages 1612-1617.

The present paper is a commentary on the recently published IEA strategy for human factors/ergonomics (Dul, J., *et al.* (2012), *A strategy for human factors/ergonomics: developing the discipline and profession. Ergonomics*, 55(4), 377–395). Two main issues that demand attention are: (i) the way others understand our profession and discipline, and (ii) the way we understand our profession and added value to industry. First, it is advocated that the discussion on the future of human factors/ergonomics (HFE) should be focused more on the quality of the delivered value of HFE and less on its visibility and marketing. Second, the three fundamental characteristics of HFE, as proposed in the report, are discussed and the consequences of this proposal are further developed. Arguments are put forward on the endemic epistemological vagueness within the discipline and on the optimistic definition of its aim. Finally, a proposal is made at the epistemological level, which challenges some established convictions of the discipline. It is advocated that such an epistemological evolution may be necessary if HFE is to make progress towards contributing to system performance.

Practitioner Summary: The paper is a commentary on the IEA strategy for human factors/ergonomics. Issues discussed are, the way others understand our profession and the way we understand our profession and added value to industry. Some of the established convictions of the discipline are challenged and proposals are made to overcome these.

- **Keywords:** future of ergonomics, marketing, positivism, systems, design

Jan Dul, Ralph Bruder, Peter Buckle, Pascale Carayon, Pierre Falzon, William S. Marras, John R. Wilson & Bas van der Doelen. *Response to the commentary 'A question of our marketing or our preconceptions'.* Pages 1618-1620.

Ipshita Chowdhury. Writing human factor research papers: a guidebook. Pages 1621-1622.

Céline McKeown. *Accident/incident prevention techniques*. Pages 1622-1623.

Jack Finnerty. *Handbook of human factors and ergonomics in health care and patient safety*. Pages 1623-1624.