



concerns about being too risk averse. The paper then describes a specific project, in rail engineering, where the notion of a human factors case has been employed to analyse engineering functions and related human factors issues. A human factors issues register for potential system disturbances has been developed, prior to a human factors risk assessment, which jointly covers safety and production (engineering delivery) concerns. The paper concludes with a commentary on the potential relevance of a resilience engineering perspective to understanding rail engineering systems risk. Design, planning and management of complex systems will increasingly have to address the issue of making trade-offs between safety and production, and ergonomics should be central to this. The paper addresses the relevant issues and does so in an under-published domain - rail systems engineering work.

- **Keywords:** human factors risk; risk assessment, rail; engineering risk; resilience engineering; function analysis

**V. Finomore; G. Matthews; T. Shaw; J. Warm. *Predicting vigilance : a fresh look at an old problem.* Pages 791–808.**

Individual differences in vigilance are ubiquitous and relevant to a variety of work environments in industrial, transportation, medical and security settings. Despite much previous work, mostly on personality traits, it remains difficult to identify vigilant operators. This paper reviews recent research that may point towards practically useful predictor variables for vigilance. Theoretical approaches to identifying predictors that accommodate the heterogeneous nature of vigilance tasks are compared. The article surveys recent empirical studies using personality measures, ability tests and scales for stress and coping as predictors of vigilance. Promising new constructs include trait scales linked to fatigue, abnormal personality and the stress state of task engagement. Implications of the data reviewed for occupational selection are discussed. Selection should be based on a multivariate assessment strategy, cognitive task analysis of the operational vigilance task and use of work sample measures to capture typical stress responses to the task. This review paper surveys recent research that may point towards practically useful predictor variables for vigilance. The article surveys recent empirical studies using personality measures, ability tests and scales for stress and coping as predictors of vigilance. Selection should be based on a multivariate assessment strategy.

- **Keywords:** vigilance; individual differences; personality; personnel selection

**M. M. P. Habraken; T. W. Van der Schaaf; I. P. Leistikow; P. M. J. Reijnders-Thijsse. *Prospective risk analysis of health care processes: A systematic evaluation of the use of HFMEA™ in Dutch health care.* Pages 809–819.**

The aim of this study was to evaluate the use of Healthcare Failure Mode and Effect Analysis (HFMEA™) in Dutch health care by means of user feedback. Thirteen HFMEA™ analyses of various health care processes were successfully concluded and on average took 69 person-hours (excluding reporting). These results show that HFMEA™ can successfully be applied in Dutch health care. However, the user feedback also uncovered several perceived drawbacks, such as the fact that HFMEA™ is very time-consuming and that, particularly, the risk assessment part of HFMEA™ is difficult to carry out. Moreover, a lack of guidance with regard to the identification of failure mode causes and effective actions might influence the quality of the outcomes of an HFMEA™ analysis. Several suggestions are put forward to improve the perceived utility and acceptance of HFMEA™. Nevertheless, future research is necessary to evaluate the actual effects of these recommendations. Error modelling and risk analysis, and their contribution to explaining human performance in socio-technical systems, traditionally belong to the field of ergonomics. The user feedback on HFMEA™ and the suggestions that are put forward

may also be useful for (H)FMEA and hazard analysis and critical control point applications in sectors other than health care.

- **Keywords:** patient safety; system failure modelling; risk assessment and management; human reliability; human error

**Jung-Keun Park; Jon Boyer; Jamie Tessler; Jeffrey Casey; Linda Schemm; Rebecca Gore; Laura Punnett; Promoting Healthy and Safe Employment (PHASE) in Healthcare Project Team. *Inter-rater reliability of PATH observations for assessment of ergonomic risk factors in hospital work. Pages 820–829.***

This study examined the inter-rater reliability of expert observations of ergonomic risk factors by four analysts. Ten jobs were observed at a hospital using a newly expanded version of the PATH method (Buchholz *et al.* 1996), to which selected upper extremity exposures had been added. Two of the four raters simultaneously observed each worker onsite for a total of 443 observation pairs containing 18 categorical exposure items each. For most exposure items, kappa coefficients were 0.4 or higher. For some items, agreement was higher both for the jobs with less rapid hand activity and for the analysts with a higher level of ergonomic job analysis experience. These upper extremity exposures could be characterised reliably with real-time observation, given adequate experience and training of the observers. The revised version of PATH is applicable to the analysis of jobs where upper extremity musculoskeletal strain is of concern.

- **Keywords:** inter-rater reliability; PATH method; ergonomic risk factor; hospital work

**Idsart Kingma; Jaap H. van Dieën. *Car driving with and without a movable back support: effect on transmission of vibration through the trunk and on its consequences for muscle activation and spinal shrinkage. Pages 830–839.***

The aim of this study was to test the effect of a movable backrest on vibration transmission through the trunk during driving and on the physiological consequences thereof. Eleven healthy male subjects drove for about 1 h on normal roads with a movable and with a fixed backrest while surface electromyography (EMG) was measured at the level of the fifth lumbar vertebra (L5) and vertical accelerations were measured at the seat, backrest and at the spine at the levels of the second sacral vertebra (S2) and seventh cervical vertebra (C7). The movable backrest significantly reduced accelerations at C7 by up to 11.9% at the 5 Hz frequency band. The movable backrest also significantly reduced the coherence and transmission between S2 and C7 accelerations, but not the differential motion between these sensors. EMG at both sides of L5 was on average 28% lower when using the movable backrest. Spinal shrinkage was unaffected by backrest type. It is concluded that a movable backrest reduces the transmission of vibration through the trunk and that it reduces low back EMG. Car driving is associated with the risk of developing low back pain and this may be related to exposure to whole body vibration. This study found an effect of a simple ergonomics measure on the transmission of vibration through the trunk as well as on back muscle activation.

- **Keywords:** whole body vibration; driving; transmission; EMG; spinal shrinkage

**Na Jin Seo. *Dependence of safety margins in grip force on isometric push force levels in lateral pinch. Pages 840–847.***

This study examined the relationship between safety margin and force level during an isometric push task in a lateral pinch posture. Ten participants grasped an object with an

aluminium- or rubber-finished grip surface using a lateral pinch posture and exerted 20%, 40%, 60%, 80% and 100% of maximum push force while voluntary grip force was recorded. Then minimum required grip force was measured for each push force level. Mean safety margin, the difference between voluntary and minimum required grip forces, was 25% maximum voluntary contraction (MVC) when averaged for all push levels. Safety margin significantly increased with increasing push force for both grip surfaces. Grip force used during maximum push exertion was only 74% lateral pinch grip MVC. Possible underlying mechanisms for increasing safety margin with increasing push force are discussed as well as the implication of this finding for ergonomic analysis. This study demonstrates that ergonomic analyses of push tasks that involve friction force should account for safety margin and reduced grip strength during the push. Failure to consider these can result in overestimation of people's push capability.

- **Keywords:** safety margin; lateral pinch; hand; grip force; push

**Nasser Koleini Mamaghani; Yoshihiro Shimomura; Koichi Iwanaga; Tetsuo Katsuura. *Effects of strap support in a hand-held device on the muscular activity in female workers assessed by electromyography and subjective rating.* Pages 848–859.**

The present study evaluates the potential mitigation of physical workload when using strap support for a portable device. The experiments were designed as consecutive sessions over a 2-h period. Electromyogram signals were recorded from four muscles of six subjects. The perceived level of fatigue on the whole body as well as in the shoulder, arm, lower back and legs was assessed using Borg's CR-10 scale. All subjects were tested under eight experimental conditions. Results indicated that the biceps brachii muscle displayed significantly lower activity with strap support than without a strap. In the experiments with and without a strap, different levels of force were imposed on the various muscles, which caused changes in the distribution of the physical load. Although the role of the strap might seem evident, using strap support did not always decrease the sensation of fatigue. However, for short-term tasks, using a strap may be recommended.

- **Keywords:** hand-held device; strap support; workload; EMG; Borg scale

**Alain Delisle; Christian Larivière; André Plamondon; Érik Salazar. *Reliability of different thresholds for defining muscular rest of the trapezius muscles in computer office workers.* Pages 860–871.**

This study aimed at documenting the reliability of different thresholds used for defining the muscular rest of the trapezius muscles of 27 computer office workers, using surface electromyography (EMG) signals collected in the field. Measurement strategies for increasing the reliability of the results were also explored. Ten different thresholds to define muscular rest were compared: 1) five normalised (individualised) thresholds; 2) three absolute thresholds (in  $\mu\text{V}$ ); 3) two absolute but individualised thresholds. The reliability was assessed using both a 15-min standardised computer task and 45 min of regular computer work. The main findings were: 1) overall, in a repeated measures study design, muscular rest variables were more reliable with the use of absolute thresholds when compared to normalised and individualised thresholds; 2) excellent reliability (index of dependability  $>0.75$ ) can be reached when averaging the scores over 2 days; 3) using a standardised task instead of regular work does not necessarily lead to more reliable results.

- **Keywords:** muscle activity; muscular rest; reliability; trapezius muscle; computer work

**Jao-Yu Yeh; Hui-Wen Liang; Yaw-Huei Hwang. *The effect of idle time thresholds on computer use time estimations by electronic monitoring.* Pages 872–881.**

This study examined the effect of idle time setting on the estimation of computer use times by electronic activity monitoring and validated its use by comparing it with video record observations. Twenty-four study subjects were recruited and their work with computers was monitored for 1 h. With the estimates by video record observation as references, the best idle time settings for electronic activity monitoring with the least relative errors were 25, 2.5 and 2.5 s, respectively, for total computer, keyboard and mouse use time estimations. These estimates were highly correlated with the corresponding references ( $r = 0.918-0.964$ ,  $p < 0.0001$ ), accompanied by limited mean estimate differences ranging from  $-3.0 \pm 2.8\%$  to  $1.3 \pm 1.6\%$ . The estimates by self-report were moderately correlated with the corresponding references ( $r = 0.387-0.678$ ), with greater mean estimate differences. This study concluded that, for electronic activity monitoring methods, the most appropriate thresholds for idle time setting are 25 s, 2.5 s and 2.5 s for total computer, keyboard and mouse use time estimates, respectively. This method may help evaluate physical work-loading with computer works through a large-scale epidemiological study.

- **Keywords:** electronic activity monitoring; computer work; computer mouse; keyboard; video record observation

**Axel Buchner; Susanne Mayr; Martin Brandt. *The advantage of positive text-background polarity is due to high display luminance.* Pages 882–886.**

Reading text from computer screens is better when text is printed in dark letters on light background (positive polarity) than when it is printed in light letters on dark background (negative polarity). An experiment is presented that tests whether this positive polarity advantage is due to the fact that overall display luminance is typically higher for positive than for negative polarity displays. To this end, text-background polarity and display luminance were manipulated independently. No positive polarity advantage was observed when overall display luminance of positive and negative polarity displays was equivalent. There was only an effect of display luminance, with better performance for the higher-luminance displays. This suggests that the positive polarity advantage is in fact due to the typically higher luminance of positive polarity displays. Readability of text presented on computer screens (e.g. on websites) is better when the overall display luminance level is high, as in positive polarity displays (dark letters on light background). Display polarity *per se* does not affect readability.

- **Keywords:** display polarity; luminance; reading