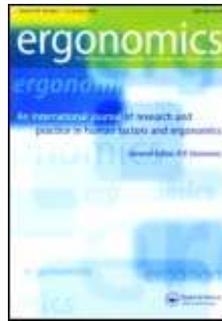


## **Ergonomics– rok 2008, ročník 51**

### **Číslo 4**



**Neville A. Stanton; Christopher Baber. *Modelling of human alarm handling response times : a case study of the Ladbroke Grove rail accident in the UK.* S. 423 – 440.**

The purpose of the paper was to address the timeliness of the signaller's intervention in the Ladbroke Grove rail incident in the UK, as well as to consider the utility of human performance time modelling more generally. Human performance response time modelling is a critical area for Human Factors and Ergonomics research. This research applied two approaches to the same problem to see if they arrived at the same conclusion. The first modelling approach used the alarm initiated activity (AIA) model. This approach is useful for indicating general response times in emergency events, but it cannot comment in detail on any specific case. The second modelling approach employed a multi-modal critical path analysis (CPA) technique. The advantage of the latter approach is that it can be used to model a specific incident on the basis of the known factors from the accident inquiry. The results show that the AIA model produced an estimated response time of 17 s, whereas the CPA model produced an estimated response time of 19 s. This compares with the actual response time of the signaller of 18 s. The response time data from both approaches are concordant and suggest that the signaller's response time in the Ladbroke Grove rail accident was reasonable. This research has application to the modelling of human responses to emergency events in all domains. Rather than the forensic reconstruction approach used in this paper, the models could be used in a predictive manner to anticipate how long human operators of safety-critical systems might take to respond in emergency scenarios.

- **Keywords:** response time; alarms; control room; performance modelling; emergency; rail system

**Robert J. Youmans; Stellan Ohlsson. *How practice produces suboptimal heuristics that render backup instruments ineffective.* S. 441 – 475.**

The operation of machines typically requires attention to instruments that signal the state of the machine. One safeguard against primary instrument malfunction is to provide backup instruments, but this works only if the operators react to malfunction by switching attention to the backups. Little is known about the effect of negative outcomes or feedback on allocation of attention to backup instruments. Four experiments demonstrated that prior practice causes operators of a simulated machine to adapt to instrument malfunction by changing to a suboptimal decision rule rather than by reallocating attention to a different set of instruments. This fallacy appears linked to the

operators' failures to notice feedback that they should switch during the simulations and operators' failures to correctly interpret outcome feedback following the simulations. The results raise theoretical questions and warn interface designers not to overrate backup instruments.

- **Keywords:** attention; heuristics; instrument failure; backup instruments; task-set switching

**Simon Hodder; Ken Pardone. *The effects of solar radiation and black body re-radiation on thermal comfort.* S. 476 – 491.**

When the sun shines on people in enclosed spaces, such as in buildings or vehicles, it directly affects thermal comfort. There is also an indirect effect as surrounding surfaces are heated exposing a person to re-radiation. This laboratory study investigated the effects of long wave re-radiation on thermal comfort, individually and when combined with direct solar radiation. Nine male participants ( $26.0 \pm 4.7$  years) took part in three experimental sessions where they were exposed to radiation from a hot black panel heated to  $100^{\circ}\text{C}$ ; direct simulated solar radiation of  $600 \text{ Wm}^{-2}$  and the combined simulated solar radiation and black panel radiation. Exposures were for 30 min, during which subjective responses and mean skin temperatures were recorded. The results showed that, at a surface temperature of  $100^{\circ}\text{C}$  (close to maximum in practice), radiation from the flat black panel provided thermal discomfort but that this was relatively small when compared with the effects of direct solar radiation. It was concluded that re-radiation, from a dashboard in a vehicle, for example, will not have a major direct influence on thermal comfort and that existing models of thermal comfort do not require a specific modification. These results showed that, for the conditions investigated, the addition of re-radiation from internal components has an effect on thermal sensation when combined with direct solar radiation. However, it is not considered that it will be a major factor in a real world situation. This is because, in practice, dashboards are unlikely to maintain very high surface temperatures in vehicles without an unacceptably high air temperature. This study quantifies the contribution of short- and long-wave radiation to thermal comfort. The results will aid vehicle designers to have a better understanding of the complex radiation environment. These include direct radiation from the sun as well as re-radiation from the dashboard and other internal surfaces.

- **Keywords:** thermal sensation; solar radiation; spectral content; radiation intensity; thermal comfort; vehicle environments; buildings

**R. M. Laing; S. T. Sims; C. A. Wilson; B. E. Niven; N. M. Cruthers. *Differences in wearer response to garments for outdoor activity.* S. 492 – 510.**

The performance of garments for outdoor activity was compared. Three fabrics, each in garments for the upper body, matched garment/wearer dimensions, were worn by 10 athletically 'well-trained' males under controlled conditions (hot  $32 \pm 2^{\circ}\text{C}$ ,  $20 \pm 2\%$  relative humidity (RH); cold  $8 \pm 2^{\circ}\text{C}$ ,  $40 \pm 2\%$  RH) with physical (instrumental) and sensory responses obtained during the trials. Differences in human responses to the fabrics/garments included heart rate, core temperature during run (hot, cold), rest (hot) and walk (cold), heat content of the body, humidity under garments during rest and run and time to onset of sweating. No such differences were identified for change in body mass, core temperature during walk (hot) and rest (cold), skin temperature, temperature of skin covered by the garment, humidity under the garments during walk or for any perceptions (thermal sensations, thermal comfort of torso, exertion, wetness). The garment in single jersey wool fabric performed best in both hot and cold conditions. Effects of garments on wearers are often related to properties of the fabrics from which the garments are made. This study shows that only some differences in fabric properties

result in measurable thermophysiological and perceptual responses of the garment wearers and underlines the difficulty in predicting performance of garments/persons from laboratory tests on fabrics.

- **Keywords:** knit fabrics; merino wool; garment-wearer responses

**Matthew S. Rogers; Alan B. Barr; Boontariga Kasemsontitum; David M. Rempel. *A three-dimensional anthropometric solid model of the hand based on landmark measurements.* S. 511 – 526.**

Hand anthropometry data are largely based on measurements of the hand in an outstretched hand posture and are, therefore, difficult to apply to tool gripping hand postures. The purpose of this project was to develop a representative, scalable hand model to be used with 3-D software drawing packages to aid in the ergonomic design of hand tools. Landmarks (66) on the palmar surface of the right hand of 100 subjects were digitised in four functional hand postures and, from these, 3-D surface models of a mean, 25th and 75th% hand were developed. The root mean square differences in hand length between the hand model and the digitised data for the 25th, 50th and 75th percentile hand were 11.4, 3.2 and 8.9 mm, respectively. The corresponding values for hand breadth were 2.0, 0.4 and 1.4 mm. There was good agreement between distances on the digitised hand and the hand model. The application of this research includes improved ergonomic hand tool design through the use of hand anthropometry reference values developed from the general population using grasping hand postures.

- **Keywords:** grasp; computer-aided design; hand, surface; hand, surface; hand tool design

**Marlene Mauch; Karen J. Mickle; Bridget J. Munro; Annaliese M. Dowling; Stefan Grau; Julie R. Steele. *Do the feet of German and Australian children differ in structure? : implications for children's shoe design.* S. 527 – 539.**

The purpose of this study was to determine whether there were any significant differences in the morphology of the feet of children living on two different continents. The shape and dimensions of the feet of 86 preschool and 419 primary school children from Australia, matched to the same number of German children for age, gender, height and BMI, were compared. The German children display significantly longer and flatter feet relative to their Australian counterparts, whereas the Australian children reveal a significantly smaller ball angle, implying that the forefoot of the Australian children is squarer in shape. These findings imply that footwear must be designed to cater to the unique foot dimensions of children in different continents to ensure that shoe shape matches foot shape. Most footwear companies do not vary the dimensions of their shoe lasts to accommodate intercontinental differences in foot morphology based on racial and/or environmental factors. The results of this study will have immediate implications for the design of comfortable footwear suitable for the developing feet of children.

- **Keywords:** foot morphology; children; shoes; footwear

**L. M. Straker; J. Coleman; R. Skoss; B. A. Maslen; R. Burgess-Limerick; C. M. Pollock. *A comparison of posture and muscle activity during tablet computer, desktop computer and paper use by young children.* S. 540 – 555**

Computers are now widely used by children. Tablet computers are becoming widely available and promoted for use by school children. The primary objective of this study was to compare the posture and muscle activity of children using a tablet computer to

the posture and muscle activity of children using a desktop computer and paper technology. Eighteen children (mean age 5.6 years) performed a colouring-in task in tablet, desktop and paper conditions. 3-D posture and muscle activity around the neck and shoulder was assessed. Tablet computer use was similar to paper use, with less neutral spinal posture, more elevated scapular posture and greater upper trapezius and cervical erector spinae activity. This was offset by greater variability of posture and muscle activity. Tablet computer use clearly results in different musculoskeletal stresses than desktop computer use. Computer use guidelines need to be appropriate to traditional and emerging technologies. Tablet computers are being promoted for use by adults and children. However, the physical impact of using this type of technology is not known. The findings of this study provide the first tablet-specific evidence to inform guidelines on wise use of tablet computers by children.

- **Keywords:** computer; children; musculoskeletal disorder; guidelines; information technology; posture; muscle activity

**A. P. Cann; M. Connolly; R. Ruuska; M. MacNeil; T. B. Birmingham; A. A. Vandervoort; J. P. Callaghan. *Inter-rater reliability of output measures for a posture matching assessment approach : a pilot study with food service workers.* S. 556 – 572.**

Despite the ongoing health problem of repetitive strain injuries, there are few tools currently available for ergonomic applications evaluating cumulative loading that have well-documented evidence of reliability and validity. The purpose of this study was to determine the inter-rater reliability of a posture matching based analysis tool (3DMatch, University of Waterloo) for predicting cumulative and peak spinal loads. A total of 30 food service workers were each videotaped for a 1-h period while performing typical work activities and a single work task was randomly selected from each for analysis by two raters. Inter-rater reliability was determined using intraclass correlation coefficients (ICC) model 2,1 and standard errors of measurement for cumulative and peak spinal and shoulder loading variables across all subjects. Overall, 85.5% of variables had moderate to excellent inter-rater reliability, with ICCs ranging from 0.30-0.99 for all cumulative and peak loading variables. 3DMatch was found to be a reliable ergonomic tool when more than one rater is involved.

- **Keywords:** reliability; cumulative loading; ergonomic evaluation; posture matching

**Linda J. Thornton; Ann E. Barr; Carol Stuart-Buttle; John P. Gaughan; Earlena R. Wilson; Andrea D. Jackson; Theresa C. Wyszynski; Claudia Smarkola. *Perceived musculoskeletal symptoms among dental students in the clinic work environment.* S. 573 – 586.**

Musculoskeletal symptoms are a major concern among dental practitioners. Dental students perform the same clinical tasks as dentists in private practice, yet only recently has scientific evidence suggested a relationship between the tasks and musculoskeletal symptoms. This study investigates the clinical tasks that place students at physical risk and the relationship between the tasks and musculoskeletal symptoms. Student perceptions of physical symptoms were established with a questionnaire identifying variables on general health, tasks, physical demands, workload and environment. A total of 61% (358/590) reported that during the past year they experienced musculoskeletal symptoms related to work at dental school (second year (n = 212), third year (n = 201) and fourth year (n = 177)). Of those students, the neck represented 48%, shoulder 31%, back 44% and hands 20% ( $p < 0.001$ ). Third year students reported the highest occurrence of symptoms in every body area ( $p < 0.001$ ). Third and fourth year students reported significant relationships between the occurrence of symptoms and equipment

utilisation, work efficiency and general health. Further studies are recommended to evaluate types and levels of potential risk factors. A total of 75% of dental practitioners are at risk for developing work-related musculoskeletal disorders. Results from this study have found that dental students were no exception. Third year dental students reported the highest level of musculoskeletal symptoms with the prevalence of pain in the neck, shoulder and lower back.

- **Keywords:** musculoskeletal symptoms; dental students; perceptions; questionnaire