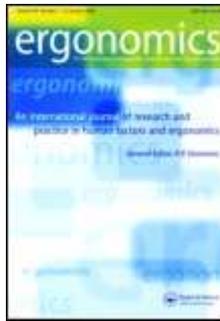


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S. R. Herring; M. S. Hallbeck. *Evaluation of a two cursor control device for development of a powered laparoscopic surgical tool. Pages 891–906.*

The current study was performed to test two electronic cursor control devices (a Touchpad and a MicroJoystick) for use in an articulating powered laparoscopic tool. A simple target acquisition test was conducted to test how well the cursor control devices could be manipulated and how accurate they were (including endpoint and movement path). The study varied the width (0.27, 0.54 and 1.07 cm) of the target as well as the hand position used (thumb and index finger control). Additionally, each participant was able to choose their ideal operating cursor speed for each cursor control device. The MicroJoystick had a higher throughput and movement variability than the Touchpad. In all other categories tested, the cursor control devices did not differ significantly. The speed of the cursor control devices did not affect the performance of the devices; therefore, the ideal cursor speed could be chosen by the participant. Finally, the hand position did not affect the performance of the devices. This experiment found both hand positions, cursor control devices and all speeds could be used to effectively manipulate an articulating end-effector in a powered, cauterising, laparoscopic tool. This article addresses the advantages and limitations of two control mechanisms for laparoscopic tool controls considering both the subjective and objective data. The controls are tested in two hand positions to test how well the participants can manipulate the device while minimising perceived fatigue.

- **Keywords:** cursor control devices; laparoscopic surgery; Fitt's Law

J. Y. C. Chen; P. I. Terrence. *Effects of imperfect automation and individual differences on concurrent performance of military and robotics tasks in a simulated multitasking environment. Pages 907–920.*

This study investigated the performance and workload of the combined position of gunner and robotics operator in a simulated military multitasking environment. Specifically, the study investigated how aided target recognition (AiTR) capabilities for the gunnery task with imperfect reliability (false-alarm-prone vs. miss-prone) might affect the concurrent robotics and communication tasks. Additionally, the study examined whether performance was affected by individual differences in spatial ability and attentional control. Results showed that when the robotics task was simply monitoring the video, participants had the best performance in their gunnery and communication tasks and the lowest perceived workload, compared with the other robotics tasking

conditions. There was a strong interaction between the type of AiTR unreliability and participants' perceived attentional control. Overall, for participants with higher perceived attentional control, false-alarm-prone alerts were more detrimental; for low attentional control participants, conversely, miss-prone automation was more harmful. Low spatial ability participants preferred visual cueing and high spatial ability participants favoured tactile cueing. Potential applications of the findings include personnel selection for robotics operation, robotics user interface designs and training development. The present results will provide further understanding of the interplays among automation reliability, multitasking performance and individual differences in military tasking environments. These results will also facilitate the implementation of robots in military settings and will provide useful data to military system designs.

- **Keywords:** human-robot interaction; military; multitasking; imperfect automation; workload; individual differences; spatial ability; attention; multimodal display; tactile

Paula M. van Wyk; Patricia L. Weir; David M. Andrews; Krysia M. Fiedler; Jack P. Callaghan. *Determining the optimal size for posture categories used in video-based posture assessment methods. Pages 921–930.*

Currently, there are no standards for the development of posture classification systems used in observation-based ergonomic posture assessment methods. This study was conducted to determine if an optimal posture category size for different body segments and posture views could be established by examining the trade-off between magnitude of error and the number of posture category misclassification errors made. Three groups (trunk flexion/extension and lateral bend; shoulder flexion/extension and adduction/abduction; elbow flexion/extension) of 30 participants each selected postures they perceived to correctly represent the video image shown on a computer screen. For each view, 10 images were presented for five different posture category sizes, three times each. The optimal posture category sizes established were 30° for trunk, shoulder and elbow flexion/extension, 30° for shoulder adduction/abduction and 15° for trunk lateral bend, suggesting that posture category size should be based on the body segment and view of the image being assessed. Across all conditions, the posture category sizes were comparable to those used in published ergonomic tools.

- **Keywords:** posture assessment; posture category; decision time; posture misclassification errors; posture category size; video

Rebecca L. Wilson; Helen C. Muir. *The effect of overwing hatch placement on evacuation from smaller transport aircraft. Pages 931–938.*

Overwing exits are installed on a number of smaller transport aircraft. With a traditional overwing exit, once released, the hatch is not attached to the fuselage and will fall into the cabin. To operate, the hatch has to be brought inwards, manoeuvred and placed in a location where it does not obstruct egress. Accidents and experimental studies have shown that the hatch is not always disposed of into an appropriate location. Evacuation trials from a smaller transport aircraft cabin were conducted. The placement of the exit hatch was manipulated. The results indicated that hatch placement had a significant effect on passenger evacuation rates from a smaller transport aircraft, with the internal placement tested resulting in slower evacuation rates. The study has highlighted the importance of operators disposing of the hatch into a location whereby it does not impede egress. One way to ensure this would be the installation of an automatically disposed hatch.

- **Keywords:** aircraft emergency evacuation; smaller transport aircraft, overwing Type III exits; exit hatch placement

Gyouhyung Kyung; Maury A. Nussbaum. *Specifying comfortable driving postures for ergonomic design and evaluation of the driver workspace using digital human models. Pages 939–953.*

Specifying comfortable driving postures is essential for ergonomic design and evaluation of a driver workspace. The present study sought to enhance and expand upon several existing recommendations for such postures. Participants (n = 38) were involved in six driving sessions that differed by vehicle class (sedan and SUV), driving venue (laboratory-based and field) or seat (from vehicles ranked high and low by vehicle comfort). Sixteen joint angles were measured in preferred postures to more completely describe driving postures, as were corresponding perceptual responses. Driving postures were found to be bilaterally asymmetric and distinct between vehicle classes, venues, age groups and gender. A subset of preferred postural ranges was identified using a filtering mechanism that ensured desired levels of perceptual responses. Accurate ranges of joint angles for comfortable driving postures, and careful consideration of vehicle and driver factors, will facilitate ergonomic design and evaluation of a driver workspace, particularly when embedded in digital human models.

- **Keywords:** digital human model; driver workspace; comfortable driving posture; preferred driving posture; filtering

Henk F. van der Molen; Judith K. Sluiter; Monique H. W. Frings-Dresen. *The use of ergonomic measures and musculoskeletal complaints among carpenters and pavers in a 4.5-year follow-up study. Pages 954–963.*

The primary aim of this follow-up study was to evaluate the association between the use of ergonomic measures and musculoskeletal complaints among construction workers during an informational campaign on sector level. A questionnaire was sent twice to a cohort of 914 Dutch carpenters and pavers, once in 2000 and once in 2005. Relative risks (RR) were calculated for the regular use of ergonomic measures and regular or sustained lower back and shoulder pain among workers at baseline and 4.5 years follow-up. The response percentages were 78% (n = 469) for carpenters and 64% (n = 202) for pavers. Regular use of specific ergonomic measures varied from 15-66% at baseline to 17-66% at follow-up. Four specific ergonomic measures showed a statistically significant increase in usage. Regular or sustained lower back and shoulder complaints among carpenters decreased from 38 to 34% ($p = 0.07$) and 24 to 22% ($p = 0.18$), respectively. Among pavers, lower back (34%) and shoulder (17 to 18%) complaints remained the same or increased. Regular use of a height-adjustable working platform was associated with a lower likelihood of shoulder complaints at baseline (RR = 0.68; 95% CI: 0.46-<1.00) and low back complaints at follow-up (RR = 0.66; 95% CI: 0.50-0.88) among carpenters. Also regular use of aids for handling heavy loads was associated with no shoulder complaints at baseline RR = 0.62 (95% CI: 0.40-0.97) among carpenters. In conclusion, despite a large informational campaign, regular use of ergonomic measures remained low in a 4.5 year period. Regular use of the majority of ergonomic measures was associated, although not statistically significantly, with a lower likelihood of lower back or shoulder complaints. It is recommended to select, apply and monitor powerful implementation strategies to ensure the use of effective ergonomic measures at construction sites.

- **Keywords:** workload; human engineering; prevention and control; musculoskeletal diseases; construction industry

Erja Sormunen; Sirkka Rissanen; Juha Oksa; Tuomo Pienimäki; Jouko Remes; Hannu Rintamäki. *Muscular activity and thermal responses in men and women during repetitive work in cold environments. Pages 964–976.*

Thermal responses and muscular activity in repetitive work were studied in eight women and eight men at 19°C (thermoneutral) and at 4°C (cold). Furthermore, effect of a heating vest was studied at 4°C. Women had lower ($p < 0.05$) mean skin temperature compared with men at each thermal condition. Muscular activity (μV) was generally higher in women compared with men, being significantly higher in m. deltoideus ($p < 0.05$). Women had lower ($p < 0.01$) maximal isometric strength compared with men, which may have influenced the observed higher muscular activity during work in women. However, compared with thermoneutral, working in cold increased ($p < 0.05$) muscular activity in the forearm and upper arm extensors only in men. The vest did not significantly counteract the increase in muscular activity. In conclusion, sex differences should be considered when evaluating cold protection and work load reduction in repetitive work in cold environments. Present results indicate that in identical work, sex affects thermal responses and muscular activity during repetitive work in conditions comparable with cooled departments in the food-processing industry. Sex differences should be considered when evaluating cold protection and preventive measures for work load reduction.

- **Keywords:** electromyography; cold exposure; auxiliary heating; sex difference; repetitive work

D. Singh; W. Park; M. S. Levy; Eui S. Jung. *The effects of obesity and standing time on postural sway during prolonged quiet standing. Pages 977–986.*

This study examined the effects of obesity level, standing time and their interaction on postural sway during a prolonged quiet upright standing task. Ten extremely obese ($\text{BMI} > 40 \text{ kg/m}^2$) and 10 non-obese ($18.5 \text{ kg/m}^2 < \text{BMI} < 24.9 \text{ kg/m}^2$) participants performed quiet upright standing on a force plate for over 18 min. Eleven postural sway measures were computed for each 1-min time interval based on the centre-of-pressure data from the force plate. ANOVA and regression analyses showed that for all the 11 postural sway measures, the extremely obese group had higher postural sway than the non-obese at the beginning of the prolonged standing task and postural sway increased significantly faster for the extremely obese group than the non-obese over time. The results suggest that obesity may impair postural control and may be a risk factor of balance loss and falls, especially during prolonged physical work activities. The research findings are relevant to identifying and reducing risks of balance loss and falls in various workplace settings for a wide variety of workers.

- **Keywords:** obesity; postural sway; functional reach; balance loss; fall; prolonged standing

Sheik N. Imrhan; M. D. Sarder; Nabeel Mandahawi. *Hand anthropometry in Bangladeshis living in America and comparisons with other populations. Pages 987–998.*

An anthropometric study of a convenience sample of 51 female and 50 male adults of Bangladeshi origin (mean age 41.3 years), living in the United States, but who spent most of their lives in Bangladesh, was conducted. Standard measurements were taken on 24 dimensions of the right hand that were relevant to the design of hand tools, gloves and access spaces using a standard sliding calliper. Analysis of the results showed significant differences in palm and finger segment lengths, breadths and depths between

genders in Bangladeshis and also within each gender between Bangladeshis and other populations. The differences between Bangladeshis and other populations were of about the same magnitude as the differences between genders in Bangladeshis. The data gathered may be used for the design of hand tools, gloves, machine access spaces and hand-held devices and for selection of hand tools for use by Bangladeshis. The study also allows inter-population comparisons that can enhance the understanding of hand anthropometry.

- **Keywords:** hand anthropometry; hand tool design; Bangladeshis

M. Mauch; S. Grau; I. Krauss; C. Maiwald; T. Horstmann. *A new approach to children's footwear based on foot type classification*. Pages 999–1008.

Current shoe designs do not allow for the comprehensive 3-D foot shape, which means they are unable to reproduce the wide variability in foot morphology. Therefore, the purpose of this study was to capture these variations of children's feet by classifying them into groups (types) and thereby provide a basis for their implementation in the design of children's shoes. The feet of 2867 German children were measured using a 3-D foot scanner. Cluster analysis was then applied to classify the feet into three different foot types. The characteristics of these foot types differ regarding their volume and forefoot shape both within and between shoe sizes. This new approach is in clear contrast to previous systems, since it captures the variability of foot morphology in a more comprehensive way by using a foot typing system and therefore paves the way for the unimpaired development of children's feet. Previous shoe systems do not allow for the wide variations in foot morphology. A new approach was developed regarding different morphological foot types based on 3-D measurements relevant in shoe construction. This can be directly applied to create specific designs for children's shoes.

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

Steve Jarvis; Don Harris. *Development of a bespoke human factors taxonomy for gliding accident analysis and its revelations about highly inexperienced UK glider pilots*. Pages 1009–1018.

Low-hours solo glider pilots have a high risk of accidents compared to more experienced pilots. Numerous taxonomies for causal accident analysis have been produced for powered aviation but none of these is suitable for gliding, so a new taxonomy was required. A human factors taxonomy specifically for glider operations was developed and used to analyse all UK gliding accidents from 2002 to 2006 for their overall causes as well as factors specific to low hours pilots. Fifty-nine categories of pilot-related accident causation emerged, which were formed into progressively larger categories until four overall human factors groups were arrived at: 'judgement'; 'handling'; 'strategy'; 'attention'. 'Handling' accounted for a significantly higher proportion of injuries than other categories. Inexperienced pilots had considerably more accidents in all categories except 'strategy'. Approach control (path judgement, airbrake and speed handling) as well as landing flare misjudgement were chiefly responsible for the high accident rate in early solo glider pilots.

- **Keywords:** gliding; glider pilots; accident; taxonomy; inexperienced; approach judgement; final approach

P. Hendrick; M. L. Bell; P. J. Bagge; S. Milosavljevic. *Can accelerometry be used to discriminate levels of activity?* Pages 1019–1025.

The aims of this study were to investigate the associations between an activity logbook and the RT3 accelerometer and to assess whether the RT3 can discriminate activity levels in healthy adults. Ten participants completed two trials wearing an RT3 accelerometer over a 4-6 h period and completed a detailed activity log. Results showed a poor correlation between the RT3 in moderate activities ($r = 0.22$) in comparison to low ($r = 0.52$) and hard ($r = 0.70$) from the logbook. A significant difference was found in average RT3 vector magnitude (VM) counts/min in each activity level ($p < 0.0001$). Discriminant analysis demonstrated that an RT3VM counts/min value of approximately 500 was found to have high sensitivity (88%), and specificity (88%) for discriminating between low and moderate activity levels from the logbook. This study found that accelerometry has the potential to discriminate activity levels in free living. This study is the first to investigate whether tri-axial accelerometry can discriminate different levels of free-living activity recorded in an activity logbook. The RT3 accelerometer can discriminate between low and moderate physical activities and offers a methodology that may be applicable to future research in occupational settings.

- **Keywords:** physical activity; activity measurement; tri-axial accelerometry; short-term free living