Don Harris, Neville A. Stanton, Alison Starr. *Spot the difference: Operational event sequence diagrams as a formal method for work allocation in the development of single-pilot operations for commercial aircraft*. Pages 1773-1791.

Function Allocation methods are important for the appropriate allocation of tasks between humans and automated systems. It is proposed that Operational Event Sequence Diagrams (OESDs) provide a simple yet rigorous basis upon which allocation of work can be assessed. This is illustrated with respect to a design concept for a passenger aircraft flown by just a single pilot where the objective is to replace or supplement functions normally undertaken by the second pilot with advanced automation. A scenario-based analysis (take off) was used in which there would normally be considerable demands and interactions with the second pilot. The OESD analyses indicate those tasks that would be suitable for allocation to automated assistance on the flight deck and those tasks that are now redundant in this new configuration (something that other formal Function Allocation approaches cannot identify). Furthermore, OESDs are demonstrated to be an easy to apply and flexible approach to the allocation of function in prospective systems. **Practitioner Summary:** OESDs provide a simple yet rigorous basis upon which allocation of work can be assessed. The technique can deal with the flexible, dynamic allocation of work and the deletion of functions no longer required. This is illustrated using a novel design concept for a single-crew commercial aircraft.

- **Keywords:** allocation of function, flight deck design, reduced crewing, operational event sequence diagrams, task analysis


Differences between preference groups based on the control scheme of the Y-axis or pitch (either default or inverted) in 3-D gaming were explored both with measures of pre-existing traits, as well as reactions to a short gaming session. Participants who preferred to invert the Y-axis controls showed significantly greater overall tendency for immersion than the non-inverters. Similarly, the participants who inverted the Y-axis also reported significantly higher levels of presence in the gaming task than the non-inverter.
Finally, when participants' controls in the gaming task were mismatched to their preference, they exhibited significantly higher perceived workload in the gaming task. Implications of these findings focus on determining a basis for differences in the population, and how these differences may impact spatial reasoning and task-specific training, especially in aviation. **Practitioner Summary:** Differing preferences for controlling a user's visual perspective in a three-dimensional virtual environment were shown to exist in the population, with indications of increased workload when randomly assigned to use a non-preferred control scheme. These control preferences showed evidence of association with the user's tendency for immersion in virtual environments.

- **Keywords:** spatial orientation, immersion, workload, virtual environments, gaming

**Nazim Gizem Forta, Marianne Schust.** *Perception of fore-and-aft whole-body vibration intensity measured by two methods.* Pages 1800-1812.

This experimental study investigated the perception of fore-and-aft whole-body vibration intensity using cross-modality matching (CM) and magnitude estimation (ME) methods. Thirteen subjects were seated on a rigid seat without a backrest and exposed to sinusoidal stimuli from 0.8 to 12.5 Hz and 0.4 to 1.6 m/s² r.m.s. The Stevens exponents did not significantly depend on vibration frequency or the measurement method. The ME frequency weightings depended significantly on vibration frequency, but the CM weightings did not. Using the CM and ME weightings would result in higher weighted exposures than those calculated using the ISO (2631-1, 1997) Wd. Compared with ISO Wk, the CM and ME-weighted exposures would be greater at 1.6 Hz and lesser above that frequency. The CM and ME frequency weightings based on the median ratings for the reference vibration condition did not differ significantly. The lack of a method effect for weightings and for Stevens exponents suggests that the findings from the two methods are comparable. **Practitioner Summary:** Frequency weighting curves for seated subjects for x-axis whole-body vibration were derived from an experiment using two different measurement methods and were compared with the Wd and Wk weighting curves in ISO 2631-1 (1997).

- **Keywords:** whole-body vibration, x-axis, frequency weighting

**Patrick Weidling, Wolfgang Jaschinski.** *The vertical monitor position for presbyopic computer users with progressive lenses: how to reach clear vision and comfortable head posture.* Pages 1813-1829.

When presbyopic employees are wearing general-purpose progressive lenses, they have clear vision only with a lower gaze inclination to the computer monitor, given the head assumes a comfortable inclination. Therefore, in the present intervention field study the monitor position was lowered, also with the aim to reduce musculoskeletal symptoms. A comparison group comprised users of lenses that do not restrict the field of clear vision. The lower monitor positions led the participants to lower their head inclination, which was linearly associated with a significant reduction in musculoskeletal symptoms. However, for progressive lenses a lower head inclination means a lower zone of clear vision, so that clear vision of the complete monitor was not achieved, rather the monitor should have been placed even lower. The procedures of this study may be useful for optimising the individual monitor position depending on the comfortable head and gaze inclination and the vertical zone of clear vision of progressive lenses. **Practitioner summary:** For users of general-purpose progressive lenses, it is suggested that low monitor positions allow for clear vision at the monitor and for a physiologically favourable head inclination. Employees may improve their workplace using a flyer providing ergonomic-optometric information.
First responders often wear personal protective equipment (PPE) for protection from on-the-job hazards. While PPE ensembles offer individuals protection, they limit one's ability to thermoregulate, and can place the wearer in danger of heat exhaustion and higher cardiac stress. Automatically monitoring thermal–work strain is one means to manage these risks, but measuring core body temperature ($T_c$) has proved problematic. An algorithm that estimates $T_c$ from sequential measures of heart rate (HR) was compared to the observed $T_c$ from 27 US soldiers participating in three different chemical/biological training events (45–90 min duration) while wearing PPE. Hotter participants (higher $T_c$) averaged (HRs) of 140 bpm and reached $T_c$ around 39°C. Overall the algorithm had a small bias (0.02°C) and root mean square error (0.21°C). Limits of agreement ($\pm 0.48°C$) were similar to comparisons of $T_c$ measured by oesophageal and rectal probes. The algorithm shows promise for use in real-time monitoring of encapsulated first responders. **Practitioner Summary:** An algorithm to estimate core temperature ($T_c$) from non-invasive measures of HR was validated. Three independent studies ($n=27$) compared the estimated $T_c$ to the observed $T_c$ in humans participating in chemical/biological hazard training. The algorithm's bias and variance to observed data were similar to that found from comparisons of oesophageal and rectal measurements.

**Keywords:** non-invasive, thermal–work strain, heat strain, fire-fighter monitoring, core temperature prediction

Vicente Javier Clemente-Suarez, José Juan Robles-Pérez. **Acute effects of caffeine supplementation on cortical arousal, anxiety, physiological response and marksmanship in close quarter combat.** Pages 1842-1850.

Previous studies have researched the ergogenic effect of caffeine in different shooting actions, but none of them in a stressful combat action. This study aimed to analyse the effect of a dose of 400 mg of caffeine monohydrate on the psycho-physiological response and marksmanship of soldiers in close quarter combat (CQC). We analysed the heart rate, blood lactate concentration, cortical arousal, state anxiety and marksmanship of 19 soldiers in the Spanish Army (38.9 ± 4.1 years; 177.4 ± 5.3 cm; 78.8 ± 7.6 kg) before and after a CQC simulation in a double-blind procedure. Caffeine intake did not improve shooting performance in CQC; however, it increased cognitive and somatic anxiety levels. **Practitioner Summary:** According to the previous literature, the ingestion of caffeine could help soldiers in operations conducted in sleep deprivation conditions, but in stressful combat situations it does not improve the marksmanship of soldiers.

**Keywords:** cortical arousal, lactate, heart rate, stress, military, marksmanship, anxiety, combat

Tessy Luger, Tim Bosch, Marco Hoozemans, Michiel de Looze, Dirkjan Veeger. **Task variation during simulated, repetitive, low-intensity work – influence on manifestation of shoulder muscle fatigue, perceived discomfort and upper-body postures.** Pages 1851-1867.

Work-related musculoskeletal disorders are increasing due to industrialisation of work processes. Task variation has been suggested as potential intervention. The objectives of this study were to investigate, first, the influence of task variation on electromyographic...
(EMG) manifestations of shoulder muscle fatigue and discomfort; second, noticeable postural shoulder changes over time; third, if the association between task variation and EMG might be biased by postural changes. Outcome parameters were recorded using multichannel EMG, Optotrak and the Borg scale. Fourteen participants performed a one-hour repetitive Pegboard task in one continuous and two interrupted conditions with rest and a pick-and-place task, respectively. Manifestations of shoulder muscle fatigue and discomfort feelings were observed throughout the conditions but these were not significantly influenced by task variation. After correction for joint angles, the relation between task variation and EMG was significantly biased but significant effects of task variation remained absent. Practitioner Summary: Comparing a one-hour continuous, repetitive Pegboard task with two interrupted conditions revealed no significant influences of task variation. We did observe that the relation between task variation and EMG was biased by posture and therefore advise taking account for posture when investigating manifestations of muscle fatigue in assembly tasks.

- Keywords: task variation, multichannel electromyography, posture, shoulder, muscle fatigue


This study investigated whether using an armrest could reduce the movements of the trunk, upper limb and hand of surgeons during simulated minimal access surgery. Sixteen surgeons carried out two trials of simulated laparoscopic surgery, one using an armrest and the other without. Reflective markers were attached on the trunk, upper limbs, fingers, minimal access camera (MAC) and scissors, allowing a motion capture system to record the movements. The error ratios during operation, subjective opinions and operative durations were collected. The results showed that total displacements at the trunk and shoulders were reduced by at least 25% when using an armrest compared with not using one; error ratios were reduced by 7%; velocity and acceleration in the trunk, shoulder and MAC were reduced. After simulated operations, 78% of the participants preferred using the armrest. The study indicates that an armrest could improve surgical outcomes by reducing trunk movements. Practitioner Summary: An armrest may help surgeons to reduce unnecessary movements during operations. The error ratios were reduced by 7% when using an armrest compared with no armrest. Displacements at the trunk and shoulders were reduced by 25% when using an armrest. Seventy-eight per cent of participants preferred to use an armrest after the experiment.

- Keywords: armrest, minimal access surgery, kinematics

Yoshihiro Shimomura, Hironori Shirakawa, Masashi Sekine, Tetsuo Katsuura, Tatsuo Igarashi. Ergonomic design and evaluation of new surgical scissors. Pages 1878-1884.

The purpose of this study is to design a new surgical scissors handle and determine its effectiveness with various usability indices. A new scissors handle was designed that retains the professional grip but has the shapes of the eye rings modified to fit the thumb and ring finger and finger rests for the index and little finger. The newly designed scissors and traditional scissors were compared by electromyography, subjective evaluation and task performance in experiments using cutting and peeling tasks. The newly designed scissors reduced muscle load in both hand during cutting by the closing action, and reduced the muscle load in the left hand during peeling by the opening action through active use of the right hand. In evaluation by surgeons, task performance improved in addition to the decrease in muscle load. The newly designed scissors used in this study demonstrated high usability. Practitioner Summary: A new scissors handle was designed that has the eye rings modified to fit the thumb and ring finger. The newly
designed scissors reduced muscle load and enabled active use of the right hand. In
evaluation by surgeons, task performance improved in addition to the decrease in muscle
load.

- **Keywords:** scissors, surgical tool, usability, product design, electromyography


This study investigated biomechanical effects of different leg folding/unfolding mechanisms used for loading/unloading two powered cots (Cots A and B) into and from a simulated ambulance. Sixteen experienced emergency medical service (EMS) workers loaded and unloaded cots with weights of 45, 68 and 91 kg placed on the cots to simulate patients. Peak back and shoulder/arm muscle activity was reduced 52–87% when using Cot A in comparison to Cot B. Peak ground reaction force (PGRF) was reduced by 74% with Cot A. Adding weight resulted in increased muscle activity and PGRF when using Cot B, but had little effect when using Cot A. Task time was longer with Cot A, though was not perceived unfavourably by participants. This study confirmed that it is possible to substantially reduce physical stress imposed on EMS workers when loading and unloading a cot to and from an ambulance through improvements in cot design. **Practitioner Summary:** This study compared two powered ambulance cots, one that lifts/lowers the front and rear wheels independently and one that lifts/lowers the four wheels simultaneously during ambulance loading and unloading. Measured muscle activity, ground reaction forces and operator perceptions support using cot designs that lift/lower the front and rear wheels independently.

- **Keywords:** ambulance cots, musculoskeletal injury, EMS, paramedic, occupational injury, engineering control, patient handling


In this study, the accuracy of the joint centres of the manikins generated by RAMSIS and Human Builder (HB), two digital human modelling (DHM) systems widely used in industry for virtual ergonomics simulation, was investigated. Eighteen variously sized females and males were generated from external anthropometric dimensions and six joint centres (knee, hip and four spine joints) were compared with their anatomic locations obtained from the three-dimensional reconstructed bones from a low-dose X-ray system. Both RAMSIS and HB could correctly reproduce external anthropometric dimensions, while the estimation of internal joint centres location presented an average error of 27.6 mm for HB and 38.3 mm for RAMSIS. Differences between both manikins showed that a more realistic kinematic linkage led to better accuracy in joint location. This study opens the way to further research on the relationship between the external body geometry and internal skeleton in order to improve the realism of the internal skeleton of DHMs, especially for a biomechanical analysis requiring information of joint load and muscle force estimation. **Practitioner summary:** This study assessed two digital human modelling (DHM) systems widely used in industry for virtual ergonomics. Results support the need of a more realistic human modelling, especially for a biomechanical analysis and a standardisation of DHMs.

- **Keywords:** digital human models, anthropometry, joint centre, stereoradiography

This paper examines the development of ergonomics in Taiwan by analysing 1404 scientific articles published by 113 permanent members of the Ergonomics Society of Taiwan (EST). Each article was classified by key words and abstract content. Each article was also coded by period of publication (1971–1992 (first period), 1993–1997 (second period), 1998–2002 (third period), 2003–2007 (fourth period), and 2008–2012 (fifth period), and against 13 topic categories. The results show that rate of publication has increased by approximately 100 articles every five years since 1993. The most popular topic was ergonomics assessment and analysis techniques in the first period, force exertion-related research in the second period, product design and evaluation in the third period, occupational safety and health in the fourth period and human–computer interface in the fifth period. Each of these is highly relevant to current contemporary issues around the world. Finally, potential areas for future ergonomics research in Taiwan are discussed. **Practitioner Summary**: This study investigates the trends in academic papers published by members of the EST. Over time, topics have shifted from ergonomics evaluation methods to occupational safety and health, and human–computer interaction. The findings should be considered as important references for planning the future of ergonomics in Taiwan.

- **Keywords**: Ergonomics Society of Taiwan, trend analysis, future of ergonomics, publication, research papers
