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Ivan Bolis, Tiago Fonseca Albuquerque Cavalcanti Sigahi, Andrew Thatcher, Patrícia Saltorato & Sandra Naomi Morioka. *Contribution of ergonomics and human factors to sustainable development: a systematic literature review*. Pages: 303-321.

Although a significant amount of research has already been published, the field of ergonomics/human factors and sustainability (E/HF-S) has not yet been systematically profiled based on recent studies. Conducting a systematic review of the literature, this article aims: (i) to identify the main emergent research themes in this subject area and (ii) to provide future directions for applied research and practice on E/HF-S. Six emergent research themes were identified in this literature allowing for a proposal to synthesise the main concepts related to E/HF-S. However, it was noted that there are still relatively few empirical papers which assess the models being developed or that apply E/HF principles to sustainability challenges. Thus, this paper identifies the opportunities for practical application related to E/HF-S. The last part of the paper explores the E/HF-S opportunities using an external framework; the United Nations' sustainable development goals. **Practitioner summary:** The field of ergonomics/human factors and sustainability (E/HF-S) has not yet been organised by recent studies. Conducting a systematic review of the literature, this article identifies the main emergent research themes in this subject area, and it provides future direction for applied research and practice on E/HF-S.

- **Keywords:** Ergonomics, Human factors, Sustainability, Sustainable Development, Systematic literature review, Practical applications

Lasse Jakobsen, Filip Gertz Lysdal, Timo Bagehorn, Uwe G. Kersting & Ion Marius Sivebaek. *The effect of footwear outsole material on slip resistance on dry and contaminated surfaces with geometrically controlled outsoles*. Pages: 322-329.

Previous studies have compared slip resistance of commercially available footwear, however, often lacking the ability to isolate factors such as material and surface properties, or/and geometry. The aim of this study was to compare slip resistance of geometrically identical shoes with varying outsole materials. Three left Ecco Xpedition III

shoes were constructed out of three different outsole materials: polyurethane (PU), thermoplastic polyurethane (TPU) and vulcanised rubber (RU). The shoes were tested for dynamic coefficient of friction (DCOF) on a steel and a tile surface, without contamination and with glycerine and canola oil as contaminants. The shoes were significantly ($p < 0.001$) different from each other across all surface/contaminant conditions/combinations, with the PU having a significantly 61–125% ($p < 0.001$) higher DCOF on contaminated surfaces compared to the RU outsole. **Practitioner summary:** Previous research has suggested the importance of studying individual parameters separately of footwear in relation to slip resistance. In this study, we managed to construct geometrically identical shoes and compare the slip resistance between three different outsole materials. We found that the polyurethane outsole was the least slippery choice of material for this specific footwear model on contaminated surfaces.

- **Keywords:** Friction, foot, wear, traction, slips trips and falls

Celeste E. Coltman, Deirdre E. McGhee & Julie R. Steele. *How much error is associated with calculating breast volume from three-dimensional breast scans obtained when women are standing? Implications for bra design and bra fit.* Pages: 330-337.

Background: A lying prone position is recommended when scanning women's breasts to ensure the entire breast can be visualised. However, several large databases contain three-dimensional scans of women's breasts and torsos that were obtained while the women were standing. This study aimed to establish the error associated with calculating breast volume from three-dimensional breast scans taken when women were standing relative to lying prone. **Methods:** Breast volume was derived for 378 women with Small, Medium, Large and Hypertrophic breast sizes from scans taken while the women were standing and then lying prone. **Results:** The magnitude of error associated with breast volume derived from scans obtained while women stood compared to lying prone, ranged from ~8–22% and increased with increasing breast size. **Conclusion:** Errors associated with breast volume data derived from breast scans collected while women stand must be accounted for, particularly for women with Medium, Large and Hypertrophic breast sizes. **Practitioner summary:** This original research provides evidence for bra designers and manufacturers on the degree of error associated when using breast scans obtained while women were standing, such as those scans readily available in large scanning databases. These errors increase with increasing breast size and must be accounted for when sizing and designing bra cups.

- **Keywords:** Breast volume, three-dimensional scanning, scanning position, bra design

Jessa M. Buchman-Pearle, Kristina M. Gruevski, Kaitlin M. Gallagher, Jeff M. Barrett & Jack P. Callaghan. *Defining the lumbar and trunk-thigh neutral zone from the passive stiffness curve: application to hybrid sit-stand postures and chair design.* Pages: 338-349.

Minimal data exist on the neutral position for the lumbar spine, trunk, and thighs when adopting a hybrid posture. This study examined sex differences in the neutral zone lumbar stiffness and the lumbar and trunk-thigh angle boundaries of the neutral zone, and determined if the standing lumbar angle fell within the neutral zone. Passive lumbar flexion and extension moment-angle curves were generated for 31 participants (13 M, 18 F), pooled from two datasets, with trunk-thigh angles available for 10 participants. The neutral zone was defined as the low stiffness zone from both the flexion and extension curves. Males demonstrated significantly greater extensor stiffness. Neutral lumbar and trunk-thigh angles ranged on average -22.2 to 0.2° and 124.2 to 159.6° for males and -17.8 to -1.3° and 143.2 to 159.5° for females, respectively. Standing

lumbar angles fell outside the neutral zone for 44% of participants. These neutral zone boundaries may inform kinematics for hybrid chair designs. **Practitioner summary:** Adoption of a neutral spinal posture may be achieved through hybrid chair design, yet minimal data exists on a physiologically defined neutral zone. Using measures of *in vivo* lumbar stiffness, the lumbar and trunk-thigh angular boundaries of the neutral zone were defined for both males and females.

- **Keywords:** Chair design, low back pain, sex, gender

Wenxiu Yang, Tingshu Chen, Haining Wang & Renke He. "Simulation of medical goggles to stop airborne transmission of viruses: computational fluid dynamics in ergonomics". Pages: 350-365.

This paper presents a position statement on combining computational fluid dynamics (CFD) and ergonomics to guide the design of personal protective equipment (PPE). We used CFD to simulate 36 exposure scenarios of an infected patient sneezing at different distances and different angles while facing either the front or the side of a healthcare worker with or without goggles. The results show that medical goggles indeed block most droplets from the outer surface, but many droplets still deposit on the bottom edge (especially at the nose), inside the air holes and on the side edge. However, the edges of medical goggles have fitment problems with people in different regions, and the air holes do not function as filters and cannot prevent fine droplets from entering the interior and contacting the eyes. Our research demonstrates the feasibility of studying the design of PPE for airtightness and protection by means of CFD. **Practitioner summary:** Computational fluid dynamics can quickly and efficiently reflect the airtightness design problems of PPE. A model was developed using CFD to examine the protective effect of medical goggles in preventing the airborne transmission of viruses. The model demonstrates the feasibility of using CFD to solve ergonomic problems.

- **Keywords:** Personal protective equipment, droplet transmission, computational fluid dynamics (CFD), airtightness product design

Yali Xia & Yoshihiro Shimomura. Relationship between anxiety and monotonous task performance in response to local cooling: an experimental study in healthy young men. Pages: 366-376.

There are limited studies on monotonous task performance and its relationship with anxiety and stress traits. This study aimed to determine if local cooling exerts physiological effects and positively affects task performance. Ten male participants performed monotonous work for 24 min under control and local cooling conditions. We measured physiological arousal and anxiety using electroencephalography and the State-Trait Anxiety Inventory, respectively. The participants rated their drowsiness, the thermal sensation of the seat and whole-body thermal sensation. Despite the lack of significant differences in physiological arousal, the state anxiety score, which reflects the current stressful situation, was significantly lower in the local cooling condition. Therefore, cooling might help relieve stress during monotonous tasks, without impairing task performance. In addition, individuals with higher state anxiety scores tended to experience a faster increase in their arousal level. Thus, individual anxiety traits may modulate attentional resources during monotonous task performance. **Practitioner summary:** The study on topic related to monotonous task performance and its relationship with anxiety and stress traits is novel. Minimising negative emotions is key to monotonous task execution under stress. Individual anxiety might modulate resource allocation for monotonous task execution.

- **Keywords:** Stress reliefstate-trait anxietylocal cooling

Matt Holman, Guy Walker & Terry Lansdown. [Analysing dynamic work systems using DynEAST: a demonstration of concept](#). Pages: 377-405.

The capability of current Ergonomics methods to capture dynamism is limited, stifling our understanding of work-as-done, distributed situational awareness and organisational drift. This paper provides a demonstration of concept of DynEAST; an extension of the EAST framework underpinned by principles from Dynamic Network Analysis, to capture elements of dynamism within work systems. The DynEAST concept is applied to a railway maintenance case study. Case study findings demonstrate how DynEAST outputs can be used to advance our understanding of the aforementioned phenomena and better equip practitioners for current and future Ergonomics challenges. **Practitioner summary:** This paper introduces the DynEAST method. DynEAST enables HF/E practitioners to model and analyse dynamic features of complex work systems. The development of DynEAST is timely due to the concurrent proliferation of increasingly complex sociotechnical systems and stagnation of HF/E methods development; particularly those able to model systemic dynamism.

- **Keywords:** Methods, dynamism, situational awareness, work as done, complexity

Ayden McCarthy, Jodie A. Wills, Jordan Andersen, Gavin K. Lenton & Tim L. A. Doyle. [Evaluating the intra- and inter-day reliability of output measures for the VALD HumanTrak: dynamic movements and range of motion of the shoulder and hip with body armour](#). Pages: 406-418.

The HumanTrak captures human movement through markerless motion tracking and can be a crucial tool in military physical screening. Reliability was examined in eighteen healthy participants who completed shoulder and hip ROM, and dynamic tasks in three body armour conditions. Generally, for all conditions, good to excellent reliability was observed in shoulder abduction and flexion, hip abduction and adduction, and dynamic squats knee and hip flexion (ICC ≥ 0.75 excluding outliers). Shoulder adduction and hip flexion demonstrated moderate to excellent reliability (ICC ≥ 0.50). Shoulder and hip extension and the drop jump were unreliable (ICC: 0.10–0.94, 0.15–0.89, and 0.30–0.82, respectively) due to the large distribution of ICC scores. Tasks with ROM values $\geq 100^\circ$ involving movement towards or perpendicular to the HumanTrak camera tended to have greater reliability than movements moving away from the camera and out of the perpendicular plane regardless if body armour was worn. **Practitioner summary:** The HumanTrak analyses ROM in a time-efficient manner in a military setting. This study established that shoulder abduction and adduction (no body armour) and shoulder, hip, and knee flexion were the most reliable measurement for all conditions. Further work is required for movements across different planes.

- **Keywords:** ICC, HumanTrakrange of motion, standard error of measurement