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Jiewei Lin, Meng Li, Zefeng Lin, Jian Wang, Xiangde Meng & Junhong Zhang. *Equivalent magnitude-dependent discomfort under vertical vibration up to 100 Hz*. Pages: 1415-1423.

The effect of vibration magnitude on frequency-dependence of discomfort of human body is always overlooked with respect to the comfort equivalence contours, particularly for high-magnitude vibration in wideband frequency. In this study, the magnitude effect of vertical vibration on discomfort of human body is investigated experimentally. Nineteen male subjects are involved in the jury test of vibration discomfort in the vertical direction with 2–5 m/s^2 in magnitude up to 100 Hz. It is shown that the growth rate of discomfort may exceed 1 due to the high-magnitude vibration employed. In this condition that the rate varies around 1, the Stevens' power law is not capable to properly represent the relationship between the subjective discomfort and the vibration magnitude. It means the equivalent comfort contours are not only dependent on the frequency range but also related to the vibration magnitude. Frequency weightings of vibration discomfort are influenced by the excitation magnitude. **Practitioner summary:** The occupant comfort to vertical whole-body vibration is affected by vibration magnitude. This study provides the effect of vibration magnitude on frequency-dependence of discomfort to whole-body vibration. It is suggested to propose variable frequency weightings for vibration discomfort evaluation under different magnitudes to achieve better comfort design.

- **Keywords:** Subjective discomfort, vibration magnitude, frequency-dependence, frequency weightings, whole-body vibration

Mengya Zhu, Dengkai Chen, Jingluan Wang, Xian Zhang & Ning Xie. *Oceanaut's personal acoustic comfort prediction model and sound environment improvement method in the cabin of a Deep-Sea manned submersible*. Pages: 1424-1448.

In this study, a personal acoustic comfort prediction model (PACPM) for exploring the acoustic comfort of oceanauts in a deep-sea manned submersible cabin was proposed, and an oceanauts' task performance model (OTPM) was constructed in this study. Based on oceanauts' comfort and task performance, the change characteristics in six different pure-noise environments (the sound pressure levels of the noise audio are 40 dB (A),

45 dB (A), 50 dB (A), 55 dB (A), 60 dB (A), and 65 dB (A) respectively) were analysed. An effective method for improving acoustic comfort was proposed. According to the analysis, personal comfort at 40 and 45 dB(A) was higher than that at other noise levels. The oceanaut's comfort and task performance of normal-weight people were significantly higher than those of thin people. Meanwhile, a comprehensive consideration of the demographic characteristics and physiological responses can effectively improve the prediction accuracy of the personnel acoustic comfort. Furthermore, the 45 dB (A) pure-noise environment overlaid with 40 dB(A) fast-paced light music effectively improves oceanauts' comfort. **Practitioner summary:** This study provides a convenient and available method for analysing acoustic comfort in the cabins of deep-sea manned submersibles, including a quantitative prediction model and an effective method for sound environment improvements. These can be used to improve the comfort, task performance, and working efficiency of manned submersibles.

- **Keywords:** Personal acoustic comfort prediction model (PACPM), oceanauts' task performance model (OTPM), methods of improving acoustic comfort, comfort analysis, deep-sea manned submersible

Mevra Temel, Andrew A. Johnson & Alex B. Lloyd. *Body mapping of skin friction coefficient and tactile perception during the dynamic skin-textile interaction*. Pages: 1449-1464.

The clothing fabric and skin interact continuously across the many regions of users' bodies during wear, which can lead to both physical skin damage and discomfort. Therefore, this investigation aimed to explore the regional differences in skin friction, tactile perception, and sensitivity in both females and males during the skin-textile interaction. The static and dynamic friction coefficient and textile perception (texture, stickiness, pleasantness, and discomfort) were measured across the 36 selected testing body areas by using a friction measurement device. The results revealed there was a significant difference in skin friction, tactile perceptions, and sensitivity across the various body regions. The anterior neck had the highest skin friction in both females and males, and participants generally rated higher texture perception in their anterior aspects compared to posterior and lateral regions. There was no significant difference in skin friction, tactile perception ratings, and sensitivity between females and males. **Practitioner summary:** This study sought to examine regional variations in skin friction, tactile perception, and sensitivity during the skin-textile interaction. There was a significant difference in skin friction, tactile perceptions, and sensitivity across the various body regions and no significant sex effect on skin friction, tactile perception ratings, and sensitivity.

- **Keywords:** Skin friction, tactile perception, clothing design, regional differences, sex

D. E. De Carvalho & J. P. Callaghan. *Effect of office chair design features on lumbar spine posture, muscle activity and perceived pain during prolonged sitting*. Pages: 1465-1476.

Chair design features are typically compared using multiple seats, which can lead to confounding effects. Using a single chair, configurable to four designs (control, lumbar support, seat pan tilt and scapular relief), we investigated the effect of chair design on spine posture and movement, muscle activity and perceived pain in a sample of 31 asymptomatic adults. A total of 39% of the population were classified as pain developers, having significantly higher peak pain levels across most body regions. The lumbar support and seat pan tilt condition resulted in more neutral spine and pelvic postures. Greater muscle activity was found in the seat pan condition and non-pain developers displayed lower spine muscle activation levels overall. Despite some improvements in spine posture, sitting-induced pain was present in the study sample at similar proportions

to those reported previously. Future studies may consider investigating interventions targeted to sitting-induced pain developers as opposed to the general population. **Practitioner summary:** Four office chair configurations were tested. The lumbar support and seat pan tilt conditions resulted in the most neutral back posture but did not mitigate the clinically significant levels of sitting-induced pain experienced by a large portion of the tested sample. Future work should target interventions to these individuals.

- **Keywords:** Office chair design, sitting, posture, EMG, spine movement

Jiao-Jiao Fang & Li-Ming Shen. *Analysis of sagittal spinal alignment at the adolescent age: for furniture design*. Pages: 1477-1493.

Knowledge of the parameters of the human spine is essential in designing ergonomic furniture. The purpose of this study was to evaluate spinal alignment in adolescents of various ages. The lengths, curvatures, and concave–convex spacings of the spine were investigated in 268 participants aged 9–18 years. Ten ages were classified, and the rate of increase of parameters was calculated for each age and age group. The results showed that spinal parameters, except for cervical lordosis, increased with age. Adolescents were classified as 9–10, 11–12, 13–15, and 16–18 years old. A rapid increment of lengths and concave–convex spacings occurred at ages 13–15, while that of curvatures occurred at ages 16–18. Spinal parameters differed significantly among the age groups ($p < 0.05$). Concave–convex spacings reflected differences in the spine more clearly than the other parameters. This study suggests the necessity of designing spine-related furniture based on spinal parameters, thus providing adaptive support for the adolescent spine, particularly the lumbar spine. **Practitioner summary:** This study examined spinal lengths, curvatures, and concave–convex spacings in adolescents aged 9–8 years and then divided them into four age groups. Concave–convex spacings effectively reflected spinal differences between age groups, particularly the lumbar spine. These results can inform the ergonomic design of spine-related furniture.

Highlights:

- Spinal parameters increased progressively between 9 and 18 years. Regression analysis showed good linear correlations between TK, LL, SK, TS, and LS with age.
- Age classification of adolescents was Group I (9–10 years), Group II (11–12 years), Group III (13–15 years), and Group IV (16–18 years). The rapid increment of lengths and concave–convex spacings were in Group III while that of curvatures were in Group IV.
- Concave–convex spacings were vital parameters to evaluate the global balance of the spine.
- The lumbar spine is an essential segment for characterizing spinal alignment.
- **Keywords:** Sagittal spinal alignment, concave–convex spacing, adolescent age classification, anthropometry, cluster analysis

J. C. F. de Winter, S. M. Petermeijer & D. A. Abbink. *Shared control versus traded control in driving: a debate around automation pitfalls*. Pages: 1494-1520.

A major question in human-automation interaction is whether tasks should be traded or shared between human and automation. This work presents reflections—which have evolved through classroom debates between the authors over the past 10 years—on these two forms of human-automation interaction, with a focus on the automated driving

domain. As in the lectures, we start with a historically informed survey of six pitfalls of automation: (1) Loss of situation and mode awareness, (2) Deskilling, (3) Unbalanced mental workload, (4) Behavioural adaptation, (5) Misuse, and (6) Disuse. Next, one of the authors explains why he believes that haptic shared control may remedy the pitfalls. Next, another author rebuts these arguments, arguing that traded control is the most promising way to improve road safety. This article ends with a common ground, explaining that shared and traded control outperform each other at medium and low environmental complexity, respectively. **Practitioner summary:** Designers of automation systems will have to consider whether humans and automation should perform tasks alternately or simultaneously. The present article provides an in-depth reflection on this dilemma, which may prove insightful and help guide design.

- **Keywords:** Human-automation interaction, human-robot interaction, human factors, shared control, traded control, automated driving, driverless cars, function allocation

Krista M. Nicklaus, Yen-Tung Liu, Chi Liu, Jevon Chu, Eloise Jewett, Karen Bravo, Mary Catherine Bordes, Jun Liu, Gregory P. Reece, Summer E. Hanson, Fatima Merchant & Mia K. Markey. *Impact of implant-based breast reconstruction on bra fit*. Pages: 1521-1533.

Comfortable and well-fitting bras are necessary for good quality of life but hard to find for women who undergo reconstruction after breast cancer treatment. This study aimed to provide data to inform bra designs for breast cancer survivors. We measured anatomical distances used in bra design on 3D clinical photographs of patients who underwent unilateral and bilateral implant-based reconstruction to quantify changes after reconstruction relative to the measured values before the person underwent surgery. We performed additional assessments of symmetry before surgery and after reconstruction, and we used regression analyses to identify associations between the measurements and patient characteristics, such as BMI. Overall, almost all measurements changed significantly in implant-based reconstructed breasts relative to native breasts. We highlight several aspects of ergonomic bra design that will be impacted by the changes in anatomical distances. **Practitioner summary:** Implant-based breast reconstruction surgery changes the breast so that off-the-rack bras are inadequate. This study provides designers with measurement data from women who underwent implant-based reconstruction to inform bra designs for this population. The key factor designers need to account for is the semi-spherical shape of the reconstructed breast.

- **Keywords:** Bra design, breast reconstruction, three-dimensional scanning, breast cancer, quality of life

Wen-Chin Li, Arthur Nichanian, John Lin & Graham Braithwaite. *Investigating the impacts of COVID-19 on aviation safety based on occurrences captured through flight data monitoring*. Pages: 1534-1548.

The COVID-19 pandemic led to growing concerns about pilots' proficiency due to the significant decrease in flight operations. The objective of this research is to provide a proactive approach to mitigate potential risks in flight operations associated with the impact of the COVID-19 pandemic using flight data monitoring (FDM). The results demonstrated significant associations between the pandemic impacts and FDM exceedance categories, flight phases and fleets. Manual flying skill decay, lack of practice effects on use of standard operating procedures and knowledge of flight deck automation should be considered by airlines when preparing for the return to normal operations. An FDM Programme allows prediction of the probability and severity of occurrences for developing an effective SMS within an airline. To mitigate the impacts of the pandemic, tailored training sessions must be implemented, and airlines should strive to avoid

additional optional procedures where practicable. **Practitioner summary:** The COVID-19 pandemic has raised concerns regarding pilot proficiency due to lack of practice effects. Results from the Flight Data Monitoring Programme show significant associations between the pandemic impacts and occurrence categories, fleets, and flight phases. FDM can be applied to mitigate the probability and severity of occurrences for airlines developing effective safety management systems.

Highlights:

- There is a significant association between the COVID-19 pandemic stages and FDM events in different flight phases, FDM categories, and aircraft types
- The COVID-19 pandemic led to a significant increase in FDM exceedances, especially for precursors on runway excursion and go-arounds
- Airlines should carefully plan training sessions for pilots as the disruptions due to the pandemic led to a lack of practice effect in flight operations
- Reviewing FDM data may have contributions to establish proactive SMS and mitigate COVID-19 impacts to aviation safety
- **Keywords:** Aviation safety, COVID-19, flight data monitoring, operational proficiency, safety resilience

George Androulakis, Tom Kontogiannis & Stathis Malakis. *Task complexity and operational risk management in military aviation*. Pages: 1549-1564.

Flight risk assessment has been based on traditional tools that are simple to use but not validated for the consideration of all relevant Complexity Contributing Factors (CCFs). This work aims to improve the process of risk management of missions in military aviation and allow for a more thorough examination of Complexity Contributing Factors (CCFs). After a series of structured workshops, a classification scheme of 46 CCFs was developed and tested in a large number of operational missions ($n = 227$). Principal Components Analysis has verified four complexity classes that provided a structure for the CCFs while multiple linear regression analysis showed that the four classes of complexity correlated well with mission success outcomes. The study provides evidence that the classification scheme of complexity considers a variety of observable markers (CCFs) which can be used to rate complexity and introduce mission changes that create a safety environment for military missions. **Practitioner summary:** This study develops a classification scheme of complexity with a large number of observable markers (Complexity Contributing Factors) that can be used to rate the complexity of missions in military aviation. Earlier studies on task complexity and a series of workshops with Subject Matter Experts (SMEs) have been used to develop the classification scheme which was validated with data from a large number of military missions.

- **Keywords:** Task complexity, operational risk management, safety, military aviation

Michael Hoven, Mien Segers, Josette Gevers & Piet Van den Bossche. *Leader airtime management and team effectiveness in emergency management command and control (EMCC) teams*. Pages: 1565-1581.

We investigated the relation between leader airtime management and team effectiveness in Emergency Management Command and Control (EMCC) teams. Leader airtime management concerns leaders' interventions to structure who shares information when using opening and closing statements to respectively stimulate or reduce information

sharing. We coded leaders' airtime management statements across different meeting phases (structuring, information sharing, decision making) using video-recordings of 12 EMCC exercises involving two consecutive meetings each. Experts rated two components of team effectiveness: Team Situation Awareness (TSA) and Team Decision Making (TDM). We found that closing statements were more frequently used in the decision-making phase than in any other meeting phase. Also, leaders of teams with lower TSA used more opening statements in the decision-making phase of the first team meeting than leaders of teams with higher TSA. These results confirm the importance of the timing of leader airtime management for EMCC team effectiveness. **Practitioner summary:** We investigated leader airtime management and team effectiveness in EMCC teams. We video-coded 12 exercises; experts rated team effectiveness. In the decision-making phase, leaders use more closing statements, and leaders of less effective teams use more opening statements. Leaders are advised to adjust their airtime management to meeting phases.

- **Keywords:** Leader airtime management, team leadership, team effectiveness, team phases, emergency management command and control teams

Cameron M. Ehnes, Michael P. Scarlett, Eric M. Adams, Randy W. Dreger & Stewart R. Petersen. *Physiological responses to treadmill exercise in size- and fitness-matched male and female firefighter applicants*. Pages: 1582-1593.

Physiological responses during a standardised treadmill test for structural firefighting employment were compared in 41 pairs of size-matched, male and female applicants. Applicants wore personal exercise clothing, running shoes, and fire protective ensemble with self-contained breathing apparatus (added mass 21.2 ± 1.0 kg). Applicants walked at 1.56 $m \cdot s^{-1}$, completing a 5-min warm-up, 8-min at 10% grade, and then, progressive 1-min stages to exhaustion. The cut-score required completion of 13-min of exercise. Up to the cut-score, no differences in heart rate, oxygen uptake or minute ventilation were detected between sexes. At time 12:30–13:00 min, $\dot{V}O_2$ was 45.7 ± 0.6 *vs.* 44.2 ± 0.5 $mL \cdot kg^{-1} \cdot min^{-1}$ (body mass) for males and females, respectively. Despite similar physiological responses at minute 13, females worked at higher fractions of peak than males ($p < 0.05$). A second analysis compared a subset of 27 fitness-matched ($\dot{V}O_{2peak}$) male-female pairs. Fitness-matching further reduced or eliminated most observed differences in physiological responses, except small differences in breathing pattern. **Practitioner Summary:** Physiological responses during a standardised treadmill test for firefighter applicants were investigated in male and female applicants matched on size and fitness. Absolute responses to exercise were the same for both sexes when size-matched, but relative intensity was higher for females. Fitness-matching reduced or eliminated most previously observed differences.

- **Keywords:** Physical employment standards, sex differences, cardiorespiratory fitness, structural firefighting, load carriage