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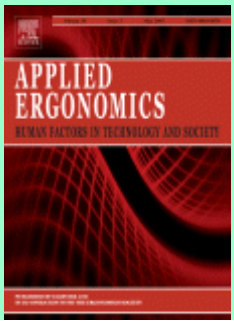

Audrey Petit, Catherine Ha, Julie Bodin, Pascal Rigouin, Alexis Descatha, René Brunet, Marcel Goldberg, Yves Roquelaure. ***Risk factors for carpal tunnel syndrome related to the work organization : a prospective surveillance study in a large working population*****. Pages 1-10.**

The study aimed to determine the risk factors for incident carpal tunnel syndrome (CTS) in a large working population, with a special focus on factors related to work organization. In 2002–2005, 3710 workers were assessed and, in 2007–2010, 1611 were re-examined. At baseline all completed a self-administered questionnaire about personal/medical factors and work exposure. CTS symptoms and physical examination signs were assessed by a standardized medical examination at baseline and follow-up. The risk of "symptomatic CTS" was higher for women (OR = 2.9 [1.7–5.2]) and increased linearly with age (OR = 1.04 [1.00–1.07] for 1-year increment). Two work organizational factors remained in the multivariate risk model after adjustment for the personal/medical and biomechanical factors: payment on a piecework basis (OR = 2.0, 95% CI 1.1–3.5) and work pace dependent on automatic rate (OR = 1.9, 95% CI 0.9–4.1). Several factors related to work organization were associated with incident CTS after adjustment for potential confounders.

- **Keywords:** Carpal tunnel syndrome; Work organization; Psychosocial factors

Andrew J. Pyke, Joseph T. Costello, Ian B. Stewart. ***Heat strain evaluation of overt and covert body armour in a hot and humid environment*****. Pages 11-15.**

The aim of this study was to elucidate the thermophysiological effects of wearing lightweight non-military overt and covert personal body armour (PBA) in a hot and humid environment. Eight healthy males walked on a treadmill for 120 min at 22% of their heart rate reserve in a climate chamber simulating 31 °C (60%RH) wearing either no armour (control), overt or covert PBA in addition to a security guard uniform, in a randomised controlled crossover design. No significant difference between conditions at the end of each trial was observed in core temperature, heart rate or skin temperature (P > 0.05). Covert PBA produced a significantly greater amount of body mass change (−1.81 ± 0.44%) compared to control (−1.07 ± 0.38%, P = 0.009) and overt conditions (−1.27 ± 0.44%, P = 0.025). Although a greater change in body mass was observed after the covert PBA trial; based on the physiological outcome measures recorded, the heat strain encountered while wearing lightweight, non-military overt or covert PBA was negligible compared to no PBA. **Practitioner summary:** The wearing of bullet proof

vests or body armour is a requirement of personnel engaged in a wide range of occupations including police, security, customs and even journalists in theatres of war. This randomised controlled crossover study is the first to examine the thermophysiological effects of wearing lightweight non-military overt and covert personal body armour (PBA) in a hot and humid environment. We conclude that the heat strain encountered while wearing both overt and covert lightweight, non-military PBA was negligible compared to no PBA.

- **Keywords:** Heat stress; Hydration; Personal protective equipment

Chris Bearman, Jared A. Grunwald, Benjamin P. Brooks, Christine Owen. *Breakdowns in coordinated decision making at and above the incident management team level : an analysis of three large scale Australian wildfires*. Pages 16-25.

Emergency situations are by their nature difficult to manage and success in such situations is often highly dependent on effective team coordination. Breakdowns in team coordination can lead to significant disruption to an operational response. Breakdowns in coordination were explored in three large-scale bushfires in Australia: the Kilmore East fire, the Wangary fire, and the Canberra Firestorm. Data from these fires were analysed using a top-down and bottom-up qualitative analysis technique. Forty-four breakdowns in coordinated decision making were identified, which yielded 83 disconnects grouped into three main categories: operational, informational and evaluative. Disconnects were specific instances where differences in understanding existed between team members. The reasons why disconnects occurred were largely consistent across the three sets of data. In some cases multiple disconnects occurred in a temporal manner, which suggested some evidence of disconnects creating states that were conducive to the occurrence of further disconnects. In terms of resolution, evaluative disconnects were nearly always resolved however operational and informational disconnects were rarely resolved effectively. The exploratory data analysis and discussion presented here represents the first systematic research to provide information about the reasons why breakdowns occur in emergency management and presents an account of how team processes can act to disrupt coordination and the operational response.

- **Keywords:** Incident management; Teamwork; Shared mental models

Alex W. Stedmon, Peter Eachus, Les Baillie, Huw Tallis, Richard Donkor, Robert Edlin-White, Robert Bracewell. *Scalable interrogation : eliciting human pheromone responses to deception in a security interview setting*. Pages 26-33.

Individuals trying to conceal knowledge from interrogators are likely to experience raised levels of stress that can manifest itself across biological, physiological, psychological and behavioural factors, providing an opportunity for detection. Using established research paradigms an innovative scalable interrogation was designed in which participants were given a 'token' that represented information they had to conceal from interviewers. A control group did not receive a token and therefore did not have to deceive the investigators. The aim of this investigation was to examine differences between deceivers and truth-tellers across the four factors by collecting data for cortisol levels, sweat samples, heart-rate, respiration, skin temperature, subjective stress ratings and video and audio recordings. The results provided an integrated understanding of responses to interrogation by those actively concealing information and those acting innocently. Of particular importance, the results also suggest, for the first time in an interrogation setting, that stressed individuals may secrete a volatile steroid based marker that could be used for stand-off detection. The findings are discussed in relation to developing a scalable interrogation protocol for future research in this area.

- **Keywords:** Hostile reconnaissance; Terrorism; Deception

Emilia Irzmańska. *The impact of different types of textile liners used in protective footwear on the subjective sensations of firefighters*. Pages 34-42.

The paper presents ergonomic evaluation of footwear used with three types of textile liners differing in terms of design and material composition. Two novel textile composite liners with enhanced hygienic properties were compared with a standard liner used in firefighter boots. The study involved 45 healthy firefighters from fire and rescue units who wore protective footwear with one of the three types of liners. The study was conducted in a laboratory under a normal atmosphere. The ergonomic properties of the protective footwear and liners were evaluated according to the standard EN ISO 20344:2012 as well as using an additional questionnaire concerning the thermal and moisture sensations experienced while wearing the footwear. The study was conducted on a much larger group of subjects (45) than that required by the ISO standard (3) to increase the reliability of subjective evaluations. Some statistically significant differences were found between the different types of textile liners used in firefighter boots. It was confirmed that the ergonomic properties of protective footwear worn in the workplace may be improved by the use of appropriate textile components.

- **Keywords:** Protective footwear; Textile liner; Comfort of use

Therese Nordberg Hanvold, Morten Wærsted, Anne Marit Mengshoel, Espen Bjertness, Kaj Bo Veiersted. *Work with prolonged arm elevation as a risk factor for shoulder pain : a longitudinal study among young adults*. Pages 43-51.

This prospective study aimed at examining if work with prolonged arm elevation predicts shoulder pain among 41 young adults in their first years of working life. Fifteen hairdressers, 15 electricians, 5 students and 6 with various work were followed over a 2.5-year period (2006/7–2009). Arm elevation was measured with inclinometers during a full working day at baseline. Shoulder pain was reported at baseline and twice in the follow-up period. Data were analyzed by generalized estimating equations (GEE-analysis), stratified by gender and adjusted for time, mechanical workload, work demand, physical activity, tobacco use and prior shoulder pain. Work with prolonged arm elevation with angles >60° and >90° were associated with shoulder pain among women. Even though the shoulder pain levels are low the study suggests work with arms elevated as an early work-related risk factor among women, and indicates the importance of early prevention strategies.

- **Keywords:** Mechanical workload; Musculoskeletal disorders; Inclinometer

Nora Balfe, Sarah Sharples, John R. Wilson. *Impact of automation : measurement of performance, workload and behaviour in a complex control environment*. Pages 52-64.

This paper describes an experiment that was undertaken to compare three levels of automation in rail signalling; a high level in which an automated agent set routes for trains using timetable information, a medium level in which trains were routed along pre-defined paths, and a low level where the operator (signaller) was responsible for the movement of all trains. These levels are described in terms of a Rail Automation Model based on previous automation theory (Parasuraman et al., 2000). Performance, subjective workload, and signaller activity were measured for each level of automation running under both normal operating conditions and abnormal, or disrupted, conditions. The results indicate that perceived workload, during both normal and disrupted phases of

the experiment, decreased as the level of automation increased and performance was most consistent (i.e. showed the least variation between participants) with the highest level of automation. The results give a strong case in favour of automation, particularly in terms of demonstrating the potential for automation to reduce workload, but also suggest much benefit can achieved from a mid-level of automation potentially at a lower cost and complexity.

- **Keywords:** Automation; Rail human factors; Workload; Performance

William J. Lewinski, Jennifer L. Dysterheft, Nathan D. Dicks, Robert W. Pettitt. *The influence of officer equipment and protection on short sprinting performance*. Pages 65-71.

As advances in protective equipment are made, it has been observed that the weight law enforcement officers must carry every day is greatly increasing. Many investigations have noted the health risks of these increases, yet none have looked at its effects on officer mobility. The primary purpose of this study was to examine the influence of both the weight of officer safety equipment, as well as a lateral focal point (FP), on the stride length, stride velocity, and acceleration of the first six strides of a short sprint. Twenty male law enforcement students performed two maximal effort sprint trials, in the participating college's gymnasium, from each of four starting positions: forwards (control position), backwards, 90° left, and 90° right. Subjects placed in the FP group (n = 9) were required to maintain focus on lateral FP during the 90° left and 90° right trials, and a forwards FP during the backwards trials. On a second testing date, subjects repeated the sprint tests while wearing a 9.07 kg weight belt, simulating officer equipment and protective gear. The belt averaged 11.47 ± 1.64% of subject body mass. A significant main effect of weight belt trials was found (F = 20.494, p < 0.01), in which significant decreases were found for velocity and acceleration. No other significant effects were found as a result of starting position or focal point and no significant interactions were found between independent variables. Conclusively, the results of this study show the increasing weights of duty gear and protective equipment have detrimental effects on officer velocity and acceleration, impeding their mobility, which may be dangerous in use of force or threatening situations.

- **Keywords:** Law enforcement officers; Sprinting performance; Equipment belt

Li Ding, Xianxue Li, Alan Hedge, Huimin Hu, David Feathers, Zhifeng Qin, Huajun Xiao, Lihao Xue, Qianxiang Zhou. *Optimizing the physical ergonomics indices for the use of partial pressure suits*. Pages 72-83.

This study developed an ergonomic evaluation system for the design of high-altitude partial pressure suits (PPSs). A total of twenty-one Chinese males participated in the experiment which tested three types of ergonomics indices (manipulative mission, operational reach and operational strength) were studied using a three-dimensional video-based motion capture system, a target-pointing board, a hand dynamometer, and a step-tread apparatus. In total, 36 ergonomics indices were evaluated and optimized using regression and fitting analysis. Some indices that were found to be linearly related and redundant were removed from the study. An optimal ergonomics index system was established that can be used to conveniently and quickly evaluate the performance of different pressurized/non-pressurized suit designs. The resulting ergonomics index system will provide a theoretical basis and practical guidance for mission planners, suit designers and engineers to design equipment for human use, and to aid in assessing partial pressure suits.

- **Keywords:** Partial pressure suit; Manipulative mission; Ergonomics index system

D.C. Tappin, T.A. Bentley, L.E. Ashby. *An implementation evaluation of a qualitative culture assessment tool*. Pages 84-92.

Safety culture has been identified as a critical element of healthy and safe workplaces and as such warrants the attention of ergonomists involved in occupational health and safety (OHS). This study sought to evaluate a tool for assessing organisational safety culture as it impacts a common OHS problem: musculoskeletal disorders (MSD). The level of advancement across nine cultural aspects was assessed in two implementation site organisations. These organisations, in residential healthcare and timber processing, enabled evaluation of the tool in contrasting settings, with reported MSD rates also high in both sectors. Interviews were conducted with 39 managers and workers across the two organisations. Interview responses and company documentation were compared by two researchers to the descriptor items for each MSD culture aspect. An assignment of the level of advancement, using a five stage framework, was made for each aspect. The tool was readily adapted to each implementation site context and provided sufficient evidence to assess their levels of advancement. Assessments for most MSD culture aspects were in the mid to upper levels of advancement, although the levels differed within each organisation, indicating that different aspects of MSD culture, as with safety culture, develop at a different pace within organisations. Areas for MSD culture improvement were identified for each organisation. Reflections are made on the use and merits of the tool by ergonomists for addressing MSD risk.

- **Keywords:** Health and safety; Safety culture; MSD

Filipe Fernandes Oliveira Dantas, Kenio Costa de Lima. *The relationship between physical load and musculoskeletal complaints among Brazilian dentists*. Pages 93-98.

The aim of the present study was to assess the relationship between physical load and musculoskeletal complaints in dentistry and to analyze the prevalence and severity of such complaints in nine anatomical regions using a cross-sectional study of 387 dentists from Natal, Brazil. The highest prevalence of complaints was related to the lower back (58.4%) and the lowest prevalence was found in the elbow (10.3%). In general, symptoms were classified as mild because they did not cause absence due to illness. Pain complaints were associated with the following characteristics: awkward posture at work; prolonged standing or sitting; strenuous position of the upper limbs; excessive tightening of the hands during clinical treatment; and the use of vibrating tools. The results of the present study suggest a high prevalence of musculoskeletal complaints in dentists that are significantly associated with variables related to their physical workload.

- **Keywords:** Dentistry; Workload; Cumulative trauma disorders

David Kaber, Carl Pankok Jr., Brendan Corbett, Wenqi Ma, Joseph Hummer, William Rasdorf. *Driver behavior in use of guide and logo signs under distraction and complex roadway conditions*. Pages 99-106.

White-on-blue logo signs on the sides of highways are typically used to notify drivers of food, gas, and lodging at an upcoming interchange. The current research assessed driver performance and attention allocation in a simulated freeway driving task when exposed to six-panel logo signs, nine-panel logo signs, mileage guide signs, and roadway work zones both with and without an in-car navigation device. The objective was to identify the impact of signage types on driver behavior under realistic driving conditions. Results revealed glance durations and fixation frequencies to guide signs to be significantly lower than with six-panel and nine-panel logo signs, but no differences were found between six-panel and nine-panel logo signs. There were also statistical differences among the independent variables for speed deviation and lane deviation, but magnitudes were not

large enough to be considered practically significant in terms of driving safety. Overall, there were minor differences in sign processing time between logo signs and mileage guide signs, but such differences did not translate to degradations in vehicle control.

- **Keywords:** Roadway logo signs; Driver performance; Driver distraction

P. Tucker, E. Bejerot, G. Kecklund, G. Aronsson, T. Åkerstedt. *The impact of work time control on physicians' sleep and well-being*. Pages 109-116.

Physicians' work schedules are an important determinant of their own wellbeing and that of their patients. This study considers whether allowing physicians control over their work hours ameliorates the effects of demanding work schedules. A questionnaire was completed by hospital physicians regarding their work hours (exposure to long shifts, short inter-shift intervals, weekend duties, night duties, unpaid overtime; and work time control), sleep (quantity and disturbance) and wellbeing (burnout, stress and fatigue). Work time control moderated the negative impact that frequent night working had upon sleep quantity and sleep disturbance. For participants who never worked long shifts, work time control was associated with fewer short sleeps, but this was not the case for those who did work long shifts. Optimizing the balance between schedule flexibility and patient needs could enhance physicians' sleep when working the night shift, thereby reducing their levels of fatigue and enhancing patient care.

- **Keywords:** Shift work; Work time control; Physicians

L. Cuvelier, P. Falzon. *The collective construction of safety : a trade-off between "understanding" and "doing" in managing dynamic situations*. Pages 117-126.

This exploratory research aims to understand how teams organize themselves and collectively manage risky dynamic situations. The objective is to assess the plausibility of a model of a collective trade-off between "understanding" and "doing". The empirical study, conducted in the pediatric anesthesia service of a French university hospital, was supported by a "high fidelity" simulation with six teams. Data on the teams' behavior and on the verbal communications were collected through video recordings. The results highlight three modes for management of dynamic situations (determined management, cautious management, and overwhelmed management). These modes are related to the way in which teams manage their cognitive resources. More precisely, they are related to the teams' ability to collectively elaborate a trade-off between "understanding" and "doing". These results question existing perspectives on safety and suggest improvements in the design of crisis management training (concerning for example the recommendation of "calling for help").

- **Keywords:** Teamwork; Safety; Adaptation

Nadine Kakarot, Friedrich Müller. *Cycling at varying load: How are experiences of perceived exertion integrated in a single measurement*? Pages 127-132.

How are experiences of perceived exertion (PE), associated with varying load, integrated in a single measurement? In search of an integrating pattern of scalings of PE, 209 participants were randomly assigned to 7.5-min pedalling trials on a bicycle-ergometer. Intensities were either kept constant at 25 W, 50 W, 75 W, 100 W, 125 W, or were systematically varied after 2.5 and 5 min whereby the overall load was kept constant at either 50 W, 75 W or 100 W. Systematically varied intensities were either continuously increased or decreased by steps of 25 W. A nearly linear relationship between steady

presented intensities and session scalings of PE confirmed the validity of the Category partitioning (CP) procedure. Scalings obtained in sessions with systematically varied loads were altered by the order of the intensity changes. The influence was more pronounced in sessions with increasing loads than in sessions with loads in decreasing order.

- **Keywords:** Scaling; Perceived exertion; Category partitioning procedure

Richard J. Holden, Christiane C. Schubert, Robin S. Mickelson. *The patient work systém : an analysis of self-care performance barriers among elderly heart failure patients and their informal caregivers*. Pages 133-150.

Human factors and ergonomics approaches have been successfully applied to study and improve the work performance of healthcare professionals. However, there has been relatively little work in "patient-engaged human factors," or the application of human factors to the health-related work of patients and other nonprofessionals. This study applied a foundational human factors tool, the systems model, to investigate the barriers to self-care performance among chronically ill elderly patients and their informal (family) caregivers. A Patient Work System model was developed to guide the collection and analysis of interviews, surveys, and observations of patients with heart failure (n = 30) and their informal caregivers (n = 14). Iterative analyses revealed the nature and prevalence of self-care barriers across components of the Patient Work System. Person-related barriers were common and stemmed from patients' biomedical conditions, limitations, knowledge deficits, preferences, and perceptions as well as the characteristics of informal caregivers and healthcare professionals. Task barriers were also highly prevalent and included task difficulty, timing, complexity, ambiguity, conflict, and undesirable consequences. Tool barriers were related to both availability and access of tools and technologies and their design, usability, and impact. Context barriers were found across three domains—physical–spatial, social–cultural, and organizational—and multiple "spaces" such as "at home," "on the go," and "in the community." Barriers often stemmed not from single factors but from the interaction of several work system components. Study findings suggest the need to further explore multiple actors, contexts, and interactions in the patient work system during research and intervention design, as well as the need to develop new models and measures for studying patient and family work.

- **Keywords:** Work system; Healthcare; Elderly patients

Annina B. Schmid, Paul A. Kubler, Venerina Johnston, Michel W. Coppieters. *A vertical mouse and ergonomic mouse pads alter wrist position but do not reduce carpal tunnel pressure in patients with carpal tunnel syndrome*. Pages 151-156.

Non-neutral wrist positions and external pressure leading to increased carpal tunnel pressure during computer use have been associated with a heightened risk of carpal tunnel syndrome (CTS). This study investigated whether commonly used ergonomic devices reduce carpal tunnel pressure in patients with CTS. Carpal tunnel pressure was measured in twenty-one patients with CTS before, during and after a computer mouse task using a standard mouse, a vertical mouse, a gel mouse pad and a gliding palm support. Carpal tunnel pressure increased while operating a computer mouse. Although the vertical mouse significantly reduced ulnar deviation and the gel mouse pad and gliding palm support decreased wrist extension, none of the ergonomic devices reduced carpal tunnel pressure. The findings of this study do therefore not endorse a strong recommendation for or against any of the ergonomic devices commonly recommended

for patients with CTS. Selection of ergonomic devices remains dependent on personal preference.

- **Keywords:** Carpal tunnel syndrome; Computer use; Ergonomic workplace

Yongqiang Lyu, Christopher James Vincent, Yu Chen, Yuanchun Shi, Yida Tang, Wenyao Wang, Wei Liu, Shuangshuang Zhang, Ke Fang, Ji Ding. *Designing and optimizing a healthcare kiosk for the community*. Pages 157-169.

Investigating new ways to deliver care, such as the use of self-service kiosks to collect and monitor signs of wellness, supports healthcare efficiency and inclusivity. Self-service kiosks offer this potential, but there is a need for solutions to meet acceptable standards, e.g. provision of accurate measurements. This study investigates the design and optimization of a prototype healthcare kiosk to collect vital signs measures. The design problem was decomposed, formalized, focused and used to generate multiple solutions. Systematic implementation and evaluation allowed for the optimization of measurement accuracy, first for individuals and then for a population. The optimized solution was tested independently to check the suitability of the methods, and quality of the solution. The process resulted in a reduction of measurement noise and an optimal fit, in terms of the positioning of measurement devices. This guaranteed the accuracy of the solution and provides a general methodology for similar design problems.

- **Keywords:** Self-service healthcare kiosk; Measurement accuracy; Parameter identification

Daniel P. Jenkins, Lisa M. Baker, Carl Harvey. *A practical approach to glare assessment for train cabs*. Pages 170-180.

The assessment of glare is a key consideration in the design of a railway driver's cab. However, unlike assessment of other factors, such as forward visibility, there are no standardised approaches for performing assessments of glare. This paper describes an approach for assessing the impact of glare in a full size mock-up of a railway cab. While it is unrealistic to evaluate every possible lighting condition that may potentially occur in the vehicle cab in service, a pragmatic and practical approach is taken to provide a good level of indicative information about the cab design's likely glare performance. This involves assessing internal light sources, such as internal lights and illuminated controls, and simulating external light sources (e.g. the sun, other trains' headlights) by illuminating the cab mock up windscreen, side and door windows with a single light source manually located in a sequence of discrete positions and orientations and assessing the resulting glare impacts. The paper describes a structured process for assessing and recording the impact of glare and recommending mitigations.

- **Keywords:** Rail; Cab design; Control layout

Richard J. Holden, Andrea Eriksson, Jörgen Andreasson, Anna Williamsson, Lotta Dellve. *Healthcare workers' perceptions of lean : a context-sensitive, mixed methods study in three Swedish hospitals*. Pages 181-192.

As the application of lean in healthcare expands, further research is needed in at least two areas: first, on the role of context in shaping lean and its consequences and second, on how healthcare workers perceive lean. Accordingly, this context-sensitive, mixed methods study addressed how hospital workers' perceptions of lean varied across contexts in three Swedish hospitals. Registered nurses and physicians at the hospitals and across units differing in acuity completed standardized surveys (N = 236, 57%

response rate) about their perceptions of hospital-wide lean implementation. Perceptions varied by: hospital context, with one hospital's employees reporting the least favorable perceptions; unit acuity, with higher-acuity units reporting more favorable perceptions; and professional role, with nurses reporting more favorable perceptions than physicians. Individual interviews, group interviews, and observations provided insight about these dissimilar contexts and possible explanations for context-specific variability. Findings are discussed with respect to strategies for implementing lean in healthcare; the importance of attending to levels, context, and worker consequences of lean; and directions for future research.

- **Keywords:** Lean healthcare; Mixed methods; Macroergonomics

Zhaosong Fang, Hong Liu, Baizhan Li, Andrew Baldwin, Jian Wang, Kechao Xia. *Experimental investigation of personal air supply nozzle use in aircraft cabins*. Pages 193-202.

To study air passengers' use of individual air supply nozzles in aircraft cabins, we constructed an experimental chamber which replicated the interior of a modern passenger aircraft. A series of experiments were conducted at different levels of cabin occupancy. Survey data were collected focused on the reasons for opening the nozzle, adjusting the level of air flow, and changing the direction of the air flow. The results showed that human thermal and draft sensations change over time in an aircraft cabin. The thermal sensation response was highest when the volunteers first entered the cabin and decreased over time until it stablized. Fifty-one percent of volunteers opened the nozzle to alleviate a feeling of stuffiness, and more than 50% adjusted the nozzle to improve upper body comfort. Over the period of the experiment the majority of volunteers chose to adjust their the air flow of their personal system. This confirms airline companies' decisions to install the individual aircraft ventilation systems in their aircraft indicates that personal air systems based on nozzle adjustment are essential for cabin comfort. These results will assist in the design of more efficient air distribution systems within passenger aircraft cabins where there is a need to optimize the air flow in order to efficiently improve aircraft passengers' thermal comfort and reduce energy use.

- **Keywords:** Aircraft cabin; Nozzle air distribution system; Nozzle use behaviour

Åse Marie Hansen, Kirsten Nabe-Nielsen, Karen Albertsen, Annie Hogh, Henrik Lund, Helge Hvid, Anne Helene Garde. *Self-rostering and psychosocial work factors : a mixed methods intervention study*. Pages 203-210.

This study aims at 1) examining the effect of self-rostering on emotional demands, quantitative demands, work pace, influence, social community at work, social support from leaders and colleagues, job satisfaction, and negative acts, 2) examining whether this effect was mediated through increased influence on the scheduling of working hours, and interpreting the results in light of the different implementation processes that emerged in the study and by including qualitative data. We conducted a 12 months follow-up, quasi-experimental study of self-rostering among 28 workplaces out of which 14 served as reference workplaces. We also interviewed 26 employees and 14 managers about their expectations of introducing self-rostering. In the present study implementation of self-rostering had a positive effect on job demands and the social environment of the workplace, especially if the intervention does not comprise drastic changes of the organisation of the employees' work and private life.

- **Keywords:** Flexible working hours; Social support

S. Hiemstra-van Mastrigt, I. Kamp, S.A.T. van Veen, P. Vink, T. Bosch. *The influence of active seating on car passengers' perceived comfort and activity levels.* Pages 211-219.

New technologies have led to an increasingly sedentary lifestyle. Sedentary behaviour is characterised by physical inactivity and is associated with several health risks. This excessive sitting does not only take place in the office or at home, but also during daily commute. Therefore, BMW AG developed an active seating system for the back seat of a car, consisting of sensors in the back rest that register upper body movements of the passenger, with which the passenger controls a game. This study evaluated three different aspects of active seating compared to other tasks (reading, working on laptop, and gaming on tablet). First, discomfort and comfort perception were measured in a 30-minute driving test. Discomfort was very low for all activities and participants felt significantly more challenged, more fit and more refreshed during active seating. Second, heart rate was measured, indicating a light intensity, but nevertheless non-sedentary, activity. Third, average and variability in activity of six postural muscles was measured by electromyography (EMG), showing a higher muscle activity and higher muscle variability for active seating compared to other activities. Active seating might stimulate movements, thereby increasing comfort and well-being.

- **Keywords:** Vehicle interior; Passenger comfort; Seating

Fiona Donald, Craig Donald, Andrew Thatcher. *Work exposure and vigilance decrements in closed circuit television surveillance*. Pages 220-228.

The aim of this study was to examine operator effectiveness in terms of detection rates and potential vigilance decrements in a proactive or real time CCTV surveillance task. The study was conducted in two stages. During stage one, 42 operators who were employed full-time in CCTV surveillance observed a 90-min video and were required to detect four types of target behaviours. No vigilance decrement was found for this sample as a whole. Stage two involved collecting additional data from 31 novices and dividing the existing operators into two sub-samples, consisting of generalists and specialists depending on the type of surveillance they performed at work (total N = 73). Fifty percent of target behaviours were detected and false alarms were high. Vigilance decrements were found for novices and generalists, but specialists maintained their performance for the first hour and then increased it. Results are discussed in terms of surveillance background, work exposure, transfer of learning, selection, training and motivation and the impact of these on vigilance and CCTV performance.

- **Keywords:** Closed circuit television; Vigilance decrement; Operator performance

P. Gendron, E. Freiberger, L. Laurencelle, F. Trudeau, C. Lajoie. *Greater physical fitness is associated with better air ventilation efficiency in firefighters*. Pages 229-235.

Firefighting is a hazardous task associated with a heavy workload where task duration may be limited by air cylinder capacity. Increased fitness may lead to better air ventilation efficiency and task duration at a given heavy work intensity. This study compared performance, air ventilation and skeletal muscle oxygen extraction during a maximal graded walking test (GWT), a 10 METS (metabolic equivalent) treadmill test (T10) and a simulated work circuit (SWC). Participants (n = 13) who performed the SWC in a shorter time had significantly lower air cylinder ventilation values on the T10 ($r = -0.495$), better peak oxygen consumption ($r = -0.924$) during the GWT and significantly greater skeletal muscle oxygen extraction during the SWC (HbDiff, $r = 0.768$). These results demonstrate that the fastest participants on the SWC had

better air ventilation efficiency that could prolong interventions in difficult situations requiring air cylinder use.

- **Keywords:** Firefighting; Work efficiency; Near infrared spectroscopy

Adriano Marçal Pimenta, Ada Ávila Assunção. *Thermal discomfort and hypertension in bus drivers and chargers in the metropolitan region of Belo Horizonte, Brazil*. Pages 236-241.

This study aimed to assess the relationship between perception of temperature inside the bus and hypertension among 1126 collective transportation workers in metropolitan region of Belo Horizonte, Brazil. Thermal discomfort was determined based on the perception of temperature inside the bus. Hypertension was determined if participant had a medical diagnosis of this disease. Prevalence ratios (PR) for hypertension and their respective 95% confidence intervals (95% CI) were adjusted using multivariate Poisson regression analysis. The perceptions of temperature inside the bus were tolerable (26.5%), disturbs a little (28.6%), disturbs a lot (34.8%) and unbearable (10.2%). The prevalence of hypertension was 14.3%. The thermal discomfort categories of disturbs a lot (PR = 1.41; 95% CI = 1.02–1.95) and unbearable (PR = 1.75; 95% CI = 1.16–2.63) were independently related to hypertension. Thermal discomfort was associated with a higher prevalence of hypertension. This finding should be considerate in new policies for public transportation.

- **Keywords:** Bus driver; Hypertension; Hot temperature

Jennie A. Jackson, Svend Erik Mathiassen, Jens Wahlström, Per Liv, Mikael Forsman. *Is what you see what you get? : standard inclinometry of set upper arm elevation angles*. Pages 242-252.

Previous research suggests inclinometers (INC) underestimate upper arm elevation. This study was designed to quantify possible bias in occupationally relevant postures, and test whether INC performance could be improved using calibration. Participants were meticulously positioned in set arm flexion and abduction angles between 0° and 150°. Different subject-specific and group-level regression models comprising linear and quadratic components describing the relationship between set and INC-registered elevation were developed using subsets of data, and validated using additional data. INC measured arm elevation showed a downward bias, particularly above 60°. INC data adjusted using the regression models were superior to unadjusted data; a subject-specific, two-point calibration based on measurements at 0° and 90° gave results closest to the 'true' set angles. Thus, inclinometer measured arm elevation data required calibration to arrive at 'true' elevation angles. Calibration to a common measurement scale should be considered when comparing arm elevation data collected using different methods.

- **Keywords:** Measurement error; Observation; Working postures

Peter A. Howarth, Simon G. Hodder. *Subjective responses to display bezel characteristics*. Pages 253-258.

High quality flat panel computer displays (FPDs) with high resolution screens are now commonplace, and black, grey, white, beige and silver surrounds ('bezels'), matt or glossy, are in widespread use. It has been suggested that bezels with high reflectance, or with a high gloss, could cause eyestrain, and we have investigated this issue. Twenty office workers (unaware of the study purpose) used six different FPDs, for a week each, at their own desk. These displays were identical apart from the bezel colour (black, white or silver) and shininess (matt or glossy). Participants completed questionnaires about

their visual comfort at the end of each week, and were fully debriefed in lunch-time focus groups at the end of the study. For the white and the silver bezels, the glossiness of the bezel was not an issue of concern. The participants were significantly less content with the glossy black surround than with the matt black surround, and in general the glossy black bezel was the least-liked of all those used. With the possible exception of this surround, there was no evidence of significantly increased visual discomfort, indicative of eyestrain, as a result of high or low bezel reflectance, or of high glossiness.

- **Keywords:** FPDs; Bezel; Gloss; Glare

Michael Y.C. Lin, Justin G. Young, Jack T. Dennerlein. *Evaluating the effect of four different pointing device designs on upper extremity posture and muscle activity during mousing tasks*. Pages 259-264.

The goal of this study was to evaluate the effect of different types of computer pointing devices and placements on posture and muscle activity of the hand and arm. A repeated measures laboratory study with 12 adults (6 females, 6 males) was conducted. Participants completed two mouse-intensive tasks while using a conventional mouse, a trackball, a stand-alone touchpad, and a rollermouse. A motion analysis system and an electromyography system monitored right upper extremity postures and muscle activity, respectively. The rollermouse condition was associated with a more neutral hand posture (lower inter-fingertip spread and greater finger flexion) along with significantly lower forearm extensor muscle activity. The touchpad and rollermouse, which were centrally located, were associated with significantly more neutral shoulder postures, reduced ulnar deviation, and lower forearm extensor muscle activities than other types of pointing devices. Users reported the most difficulty using the trackball and touchpad. Rollermouse was not more difficult to use than any other devices. These results show that computer pointing device design and location elicit significantly different postures and forearm muscle activities during use, especially for the hand posture metrics.

- **Keywords:** Pointing device; Computer tasks; Musculoskeletal disorders

J. Rechard, A. Bignon, P. Berruet, T. Morineau. *Verification and validation of a Work Domain Analysis with turing machine task analysis*. Pages 265-273.

While the use of Work Domain Analysis as a methodological framework in cognitive engineering is increasing rapidly, verification and validation of work domain models produced by this method are becoming a significant issue. In this article, we propose the use of a method based on Turing machine formalism named "Turing Machine Task Analysis" to verify and validate work domain models. The application of this method on two work domain analyses, one of car driving which is an "intentional" domain, and the other of a ship water system which is a "causal domain" showed the possibility of highlighting improvements needed by these models. More precisely, the step by step analysis of a degraded task scenario in each work domain model pointed out unsatisfactory aspects in the first modelling, like overspecification, underspecification, omission of work domain affordances, or unsuitable inclusion of objects in the work domain model.

- **Keywords:** Work domain analysis; Validation; Turing machine task analysis

Ching-Min Cheng, Sheue-Ling Hwang. *Applications of integrated human error identification techniques on the chemical cylinder change task*. Pages 274-284.

This paper outlines the human error identification (HEI) techniques that currently exist to assess latent human errors. Many formal error identification techniques have existed for years, but few have been validated to cover latent human error analysis in different domains. This study considers many possible error modes and influential factors, including external error modes, internal error modes, psychological error mechanisms, and performance shaping factors, and integrates several execution procedures and frameworks of HEI techniques. The case study in this research was the operational process of changing chemical cylinders in a factory. In addition, the integrated HEI method was used to assess the operational processes and the system's reliability. It was concluded that the integrated method is a valuable aid to develop much safer operational processes and can be used to predict human error rates on critical tasks in the plant.

- **Keywords:** Human errors; Human reliability analysis; Safety management

Anna-Carin Fagerlind Ståhl, Maria Gustavsson, Nadine Karlsson, Gun Johansson, Kerstin Ekberg. *Lean production tools and decision latitude enable conditions for innovative learning in organizations : a multilevel analysis*. Pages 285-291.

The effect of lean production on conditions for learning is debated. This study aimed to investigate how tools inspired by lean production (standardization, resource reduction, visual monitoring, housekeeping, value flow analysis) were associated with an innovative learning climate and with collective dispersion of ideas in organizations, and whether decision latitude contributed to these associations. A questionnaire was sent out to employees in public, private, production and service organizations (n = 4442). Multilevel linear regression analyses were used. Use of lean tools and decision latitude were positively associated with an innovative learning climate and collective dispersion of ideas. A low degree of decision latitude was a modifier in the association to collective dispersion of ideas. Lean tools can enable shared understanding and collective spreading of ideas, needed for the development of work processes, especially when decision latitude is low. Value flow analysis played a pivotal role in the associations.

- **Keywords:** Psychosocial work conditions; Job resources; Learning climate

Stephen Wright, David O'Hare. *Can a glass cockpit display help (or hinder) performance of novices in simulated flight training?* Pages 292-299.

The analog dials in traditional GA aircraft cockpits are being replaced by integrated electronic displays, commonly referred to as glass cockpits. Pilots may be trained on glass cockpit aircraft or encounter them after training on traditional displays. The effects of glass cockpit displays on initial performance and potential transfer effects between cockpit display configurations have yet to be adequately investigated. Flight-naïve participants were trained on either a simulated traditional display cockpit or a simulated glass display cockpit. Flight performance was measured in a test flight using either the same or different cockpit display. Loss of control events and accuracy in controlling altitude, airspeed and heading, workload, and situational awareness were assessed. Preferences for cockpit display configurations and opinions on ease of use were also measured. The results revealed consistently poorer performance on the test flight for participants using the glass cockpit compared to the traditional cockpit. In contrast the post-flight questionnaire data revealed a strong subjective preference for the glass cockpit over the traditional cockpit displays. There was only a weak effect of prior training. The specific glass cockpit display used in this study was subjectively appealing but yielded poorer flight performance in participants with no previous flight experience than a traditional display. Performance data can contradict opinion data. The design of

glass cockpit displays may present some difficulties for pilots in the very early stages of training.

- **Keywords:** Cockpit displays; Flight performance

Steven Curnin, Christine Owen, Douglas Paton, Benjamin Brooks. *A theoretical framework for negotiating the path of emergency management multi-agency coordinatio*n. Pages 300-307.

Multi-agency coordination represents a significant challenge in emergency management. The need for liaison officers working in strategic level emergency operations centres to play organizational boundary spanning roles within multi-agency coordination arrangements that are enacted in complex and dynamic emergency response scenarios creates significant research and practical challenges. The aim of the paper is to address a gap in the literature regarding the concept of multi-agency coordination from a human–environment interaction perspective. We present a theoretical framework for facilitating multi-agency coordination in emergency management that is grounded in human factors and ergonomics using the methodology of core-task analysis. As a result we believe the framework will enable liaison officers to cope more efficiently within the work domain. In addition, we provide suggestions for extending the theory of core-task analysis to an alternate high reliability environment.

- **Keywords:** Emergency management; Multi-organizational core-task analysis; Boundary spanning

Jasper van Kuijk, Liesbeth van Driel, Daan van Eijk. *Usability in product development practice : an exploratory case study comparing four markets*. Pages 308-323.

This study explored how usability was dealt with in four product development organizations active in different sectors: high-end automotive, professional printers and copiers, office coffee makers and fast moving consumer goods. The primary differentiators of the selected cases were whether they were targeting businesses or consumers and the degree of product complexity. Interviews with 19 product development practitioners were conducted, focussing on three topics: 1) the product development process and the integration of user involvement, 2) multidisciplinary teamwork, and 3) organizational attitude towards usability. Based on the interviews, context descriptions of the companies were created and barriers and enablers for usability were identified. To verify the findings and to discuss remaining issues a feedback workshop was held in which the primary contact from each company participated. The results indicate that differences in product–market combination lead to differences in organizational attitude towards usability. The prioritization of usability in an organization seems to be influenced by the degree of product complexity (complex products are more prone to suffer from usability issues) and whether developers think that usability is a purchase consideration for their clients. The product–market combination a company targets also affects the methods for user-centred design that a company can apply and that are relevant. What methods for user-centred design are used also seems to be influenced by the attitude towards usability: if usability is considered more important, methods that require more resources can be applied.

- **Keywords:** Product ergonomics; Usability; Ergonomics integration

Sian Christina, Patrick Waterson, Andrew Dainty, Kevin Daniels. *A socio-technical approach to improving retail energy efficiency behaviours*. Pages 324-335.

In recent years, the UK retail sector has made a significant contribution to societal responses on carbon reduction. We provide a novel and timely examination of environmental sustainability from a systems perspective, exploring how energy-related technologies and strategies are incorporated into organisational life. We use a longitudinal case study approach, looking at behavioural energy efficiency from within one of the UK's leading retailers. Our data covers a two-year period, with qualitative data from a total of 131 participants gathered using phased interviews and focus groups. We introduce an adapted socio-technical framework approach in order to describe an existing organisational behavioural strategy to support retail energy efficiency. Our findings point to crucial socio-technical and goal-setting factors which both impede and/or enable energy efficient behaviours, these include: tensions linked to store level perception of energy management goals; an emphasis on the importance of technology for underpinning change processes; and, the need for feedback and incentives to support the completion of energy-related tasks. We also describe the evolution of a practical operational intervention designed to address issues raised in our findings. Our study provides fresh insights into how sustainable workplace behaviours can be achieved and sustained over time. Secondly, we discuss in detail a set of issues arising from goal conflict in the workplace; these include the development of a practical energy management strategy to facilitate secondary organisational goals through job redesign.

- **Keywords:** Energy efficiency; Multiple goal conflict; Job design

Francis T. Durso, Sadaf Kazi, Ashley N. Ferguson. *The Threat-Strategy Interview*. Pages 336-344.

Operators in dynamic work environments use strategies to manage threats in order to achieve task goals. We introduce a structured interview method, the Threat-Strategy Interview (TSI), and an accompanying qualitative analysis to induce operator-level threats, strategies, and the cues that give rise to them. The TSI can be used to elicit knowledge from operators who are on the front line of managing threats to provide an understanding of strategic thinking, which in turn can be applied toward a variety of problems.

- **Keywords:** Strategies; Knowledge elicitation; Threat and error management

Francis T. Durso, Ashley N. Ferguson, Sadaf Kazi, Charlene Cunningham, Christina Ryan. *Strategic threat management : an exploration of nursing strategies in the pediatric intensive care unit*. Pages 345-354.

Part of the work of a critical care nurse is to manage the threats that arise that could impede efficient and effective job performance. Nurses manage threats by employing various strategies to keep performance high and workload manageable. We investigated strategic threat management by using the Threat-Strategy Interview. Threats frequently involved technology, staff, or organizational components. The threats were managed by a toolbox of multifaceted strategies, the most frequent of which involved staff-, treatment- (patient + technology), examination- (patient + clinician), and patient-oriented strategies. The profile of strategies for a particular threat often leveraged work facets similar to the work facet that characterized the threat. In such cases, the nurse's strategy was directed at eliminating the threat (not working around it). A description at both a domain invariant level – useful for understanding strategic threat management generally – and a description at an operational, specific level – useful for guiding interventions-- are presented. A structural description of the relationship among threats, strategies, and the cues that trigger them is presented in the form of an evidence accumulation framework of strategic threat management.

- **Keywords:** Strategies; Interviews; Nursing