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Errol R. Hoffmann & Alan H.S. Chan. *Alternative approaches to the design of four-burner stoves.* Pages 777-791.

The spatial arrangement of stove hotplates and associated controls and linkages has been of concern to ergonomists. In this study, two different approaches were used to determine preferred arrangements. In the first, one group of participants were given locations of controls and asked to place hotplates; a second group was given hotplate locations and asked to place controls. In each case, linkages were to be indicated. In the second approach, drawings of stove layouts with controls and linkages were given. Scales of preference of control/hotplate layouts were established. Arrangements having high spatial congruence between hotplate and controls were nominated and most preferred by participants in the first approach. In the second approach, it was found possible to discriminate between arrangements that had high spatial congruence and high compatibility between hotplate and control and, hence, to determine 'best' designs in terms of participant preferences. **Statement of Relevance:** Most research on stove layout has been with hotplates in a square arrangement. Two different approaches to design show the importance of spatial congruence between hotplate and control for obtaining preferred designs having high compatibility, which are superior from an ergonomics viewpoint.

- **Keywords:** compatibility, control/hotplate arrangements, expectancies, stove layout

C. Baber, C. Morin, M. Parekh, M. Cahillane & R.J. Houghton. *Multimodal control of sensors on multiple simulated unmanned vehicles.* Pages 792-805.

The use of multimodal (speech plus manual) control of the sensors on combinations of one, two, three or five simulated unmanned vehicles (UVs) is explored. Novice controllers of simulated UVs complete a series of target checking tasks. Two experiments compare speech and gamepad control for one, two, three or five UVs in a simulated environment. Increasing the number of UVs has an impact on subjective rating of workload (measured by NASA-Task Load Index), particularly when moving from one to three UVs. Objective measures of performance showed that the participants tended to issue fewer commands as the number of vehicles increased (when using the gamepad control), but, while performance with a single UV was superior to that of multiple UVs, there was little

difference across two, three or five UVs. Participants with low spatial ability (measured by the Object Perspectives Test) showed an increase in time to respond to warnings when controlling five UVs. Combining speech with gamepad control of sensors on UVs leads to superior performance on a secondary (respond-to-warnings) task (implying a reduction in demand) and use of fewer commands on primary (move-sensors and classify-target) tasks (implying more efficient operation). **Statement of Relevance:** Benefits of multimodal control for unmanned vehicles are demonstrated. When controlling sensors on multiple UVs, participants with low spatial orientation scores have problems. It is proposed that the findings of these studies have implications for selection of UV operators and suggests that future UV workstations could benefit from multimodal control.

- **Keywords:** unmanned vehicles, multimodal interaction, speech recognition

Hsin-Chieh Wu. *Electronic paper display preferred viewing distance and character size for different age groups. Pages 806-814.*

This study explores the preferred viewing distance and character size for an electronic paper display for three age groups. Proofreading speed and accuracy ratio were measured during Chinese proofreading tests using the preferred character size and minimum acceptable character size. Data analysis showed that the mean preferred viewing distance for young, middle-aged and older groups was 503, 455 and 444 mm, respectively. The mean preferred character size determined by young, middle-aged and older groups was 42.0, 50.0 and 55.2 min arc, respectively. The proofreading test results indicated that the older group proofread significantly more slowly (1.25word/sec) than the young (1.76 word/sec) and middle-aged groups (1.74 word/sec). Further, the participants proofread more correctly with their preferred character size (73.3%) than with their minimum acceptable character size (65.4%). This study provides valuable information for the design of Chinese text presentations for various agegroups. **Statement of Relevance:** This study confirmed the preferred viewing distance and character size for E-paper display were influenced by age. The preferred Chinese character size for young, middle-aged and older people was 42, 50 and 55 min arc, respectively. Therefore, the age factor should be considered for E-paper displays design and video display terminal (VDT) guidelines.

- **Keywords:** office ergonomics, ageing, information displays, standards

Linsey M. Barker & Maury A. Nussbaum. *The effects of fatigue on performance in simulated nursing work. Pages 815-829.*

Fatigue is associated with increased rates of medical errors and healthcare worker injuries, yet existing research in this sector has not considered multiple dimensions of fatigue simultaneously. This study evaluated hypothesised causal relationships between mental and physical fatigue and performance. High and low levels of mental and physical fatigue were induced in 16 participants during simulated nursing work tasks in a laboratory setting. Task-induced changes in fatigue dimensions were quantified using both subjective and objective measures, as were changes in performance on physical and mental tasks. Completing the simulated work tasks increased total fatigue, mental fatigue and physical fatigue in all experimental conditions. Higher physical fatigue adversely affected measures of physical and mental performance, whereas higher mental fatigue had a positive effect on one measure of mental performance. Overall, these results suggest causal effects between manipulated levels of mental and physical fatigue and task-induced changes in mental and physical performance. **Statement of Relevance:** Nurse fatigue and performance has implications for patient and provider safety. Results from this study demonstrate the importance of a multidimensional view of fatigue in understanding the causal relationships between fatigue and performance. The

findings can guide future work aimed at predicting fatigue-related performance decrements and designing interventions.

- **Keywords:** fatigue, healthcare, nursing, performance, workload

Robert S. Bridger & Kate Brasher. *Cognitive task demands, self-control demands and the mental well-being of office workers.* Pages 830-839.

The cognitive task demands of office workers and the self-control demands of their work roles were measured in a sample of 196 employees in two different office layouts using a self-report questionnaire, which was circulated electronically. Multiple linear regression analysis revealed that both factors were associated with mental well-being, but not with physical well-being, while controlling for exposure to psychosocial stressors. The interaction between cognitive task demands and self-control demands had the strongest association with mental well-being, suggesting that the deleterious effect of one was greater when the other was present. An exploratory analysis revealed that the association was stronger for employees working in a large open-plan office than for those working in smaller offices with more privacy. Frustration of work goals was the cognitive task demand having the strongest negative impact on mental well-being. Methodological limitations and scale psychometrics (particularly the use of the NASA Task Load Index) are discussed. **Statement of Relevance:** Modern office work has high mental demands and low physical demands and there is a need to design offices to prevent adverse psychological reactions. It is shown that cognitive task demands interact with self-control demands to degrade mental well-being. The association was stronger in an open-plan office.

- **Keywords:** cognitive task demands, cognitive TLX, NASA TLX, office design, privacy, self-control demands

J. J. Devereux, L. W. Rydstedt & M. Cropley. *Psychosocial work characteristics, need for recovery and musculoskeletal problems predict psychological distress in a sample of British workers.* Pages 840-848.

From an original sample of 2454 participants free of self-reported psychological distress, 1463 workers completed a 15-month follow-up. Baseline measures included exposure to job demands, decision latitude, social support and need for recovery. Psychological distress was assessed using the General Health Questionnaire at baseline and at follow-up. The findings showed that medium and high exposure to job demands and social support increased the risk of reporting psychological distress at 15-months (relative risk (RR) = 1.65, 1.45). The highest adjusted RR was observed for workers reporting a high need for recovery after work (RR 2.12, 1.90) and this finding was independent of the effects of job demands, decision latitude and social support. Neither decision latitude, nor low back problems increased the risk of reporting future psychological distress, although neck problems (RR = 1.66) and hand/wrist problems (RR = 1.45) did. It was concluded that need for recovery appears to be an important indicator of individual workers who are at risk of developing psychological distress long term. **Statement of Relevance:** This paper reports the findings of a longitudinal study showing that need for recovery from work was the strongest predictor, relative to psychosocial work characteristics (job demands, decision latitude and social support), and musculoskeletal problems, of psychological distress 15 months later in individuals initially free from distress.

- **Keywords:** demands, need for recovery, psychological distress, social support

Cheol-Min Lim, Myung-Chul Jung & Yong-Ku Kong. *Evaluation of upper-limb body postures based on the effects of back and shoulder flexion*

angles on subjective discomfort ratings, heart rates and muscle activities. Pages 849-857.

A possible limitation of many ergonomics checklists that evaluate postures is an independent evaluation of each body segment without considering the coordination between body segments and resulting in the under-/over-estimation of body postures. A total of 20 men were selected to evaluate the effects of shoulder and back flexion angles on the upper-limb muscle activities, subjective discomforts and heart rates. Interesting findings were obtained from the coordination between back flexion angles and shoulder flexion angles. At a back flexion angle of 45°, the discomfort and heart rates were the least at a shoulder flexion angle of 45°. The %MVC also showed a similar trend. It could be inferred that the 0° shoulder flexion angle would be a natural posture, when the back flexion angle is 0°, whereas 45° shoulder flexion might be a more natural posture when the back flexion angle is 45°. **Statement of Relevance:** This study evaluated the effects of back and shoulder flexion angles on subjective as well as objective measures. The findings of this study considered the coordination between two body flexion angles and could be used to improve the accuracy of existing ergonomics evaluation methods for body postures.

- **Keywords:** WMSDs, subjective ratings, heart rates, EMG, back and shoulder angles

Daniel Cury Ribeiro, Gisela Sole, J. Haxby Abbott & Stephan Milosavljevic. Cumulative postural exposure measured by a novel device : a preliminary study. Pages 858-865.

The aim of the present study was to examine the within-day reliability of the Spineangel® postural monitoring device and to measure cumulative lumbo-pelvic posture exposure of health care workers. Twenty-one workers from an aged-care residential home wore the Spineangel, attached to the belt or waistband of their normal work apparel, during a period of the work shift. To assess the within-day reliability of measurements, 11 workers performed two sets of three lumbo-pelvic forward flexion, sustaining them for five 5 s each, at the beginning and at the end of the work shift. Different thresholds for cumulative postural exposure were measured. The reliability was found to be excellent (ICC = 0.81). On average, a threshold of 30° of lumbo-pelvic forward flexion was exceeded 1069 times/h (SD 2157.1); at 45°, 121 times/h (SD 223.8); and at 60°, 8 times/h (SD 21.8). The use of Spineangel isthus likely to be a useful device for monitoring work posture. **Statement of Relevance:** The Spineangel® is capable of providing reliable postural measurements in the workplace. Different cumulative postural exposure thresholds were established considering three domains of cumulative exposure: magnitude (range of motion), frequency and duration. The implementation of such domains for cumulative exposure allowed us to explore interesting forms of monitoring posture exposure.

- **Keywords:** posture, reliability, trunk posture analysis, low back pain, posture monitoring

Reena Pandarum, Winnie Yu & Lawrance Hunter. 3-D breast anthropometry of plus-sized women in South Africa. Pages 866-875.

Exploratory retail studies in South Africa indicate that plus-sized women experience problems and dissatisfaction with poorly fitting bras. The lack of 3-D anthropometric studies for the plus-size women's bra market initiated this research. 3-D body torso measurements were collected from a convenience sample of 176 plus-sized women in South Africa. 3-D breast measurements extracted from the TC² NX12-3-D body scanner 'breast module' software were compared with traditional tape measurements. Regression equations show that the two methods of measurement were highly correlated although,

on average, the bra cup size determining factor 'bust minus underbust' obtained from the 3-D method is approximately 11% smaller than that of the manual method. It was concluded that the total bust volume correlated with the quadrant volume ($r = 0.81$), cup length, bust length and bust prominence, should be selected as the overall measure of bust size and not the traditional bust girth and the underbust measurement. **Statement of Relevance:** This study contributes new data and adds to the knowledge base of anthropometry and consumer ergonomics on bra fit and support, published in this, the *Ergonomics Journal*, by Chen *et al.* (2010) on bra fit and White *et al.* (2009) on breast support during overground running.

- **Keywords:** 3-D body scanner, bra fit, breast volume, plus-sized women, South Africa