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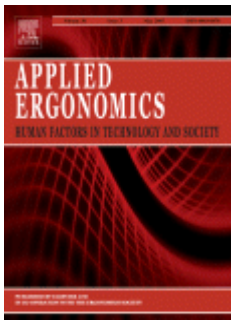

Yen-Hui Lin, Chih-Yong Chen, Shih-Yi Lu. *Physical discomfort and psychosocial job stress among male and female operators at telecommunication call centers in Taiwan*. S. 561-568.

The prevalence of job stress, distributions of major job stressors, and associations between perceived job stress levels and multiple physical discomforts are assessed via a cross-sectional study of 1023 male and female operators at telecommunication call centers in Taiwan. Cases of discomfort are identified via questionnaire surveys requiring respondents to self-reported symptoms of discomfort. Information is obtained on demographics, health status, perceived job stress levels, major job stressors and psychosocial job characteristics. Multivariate logistic regression models are developed to predict physical discomfort in nine body areas. 'Eye strain', 'hoarse or painful throat' and 'musculoskeletal discomfort' are the most pronounced and prevalent complaints after prolonged work time at call centers. Female operators had higher prevalence of physical discomfort than male operators for all body areas. 'Encountering difficult customers' ranked as the most important job stress factor among both male and female operators. Working in a call center for more than 4 years is strongly associated with discomfort in all body areas (odds ratio ranges from 1.65 to 2.15). Analysis of risk factors vs. physical discomfort reveals that operators who perceive higher job stress have significantly increased risk of several health complaints, including eye strain, tinnitus, hoarse or painful throat, chronic cough with phlegm, chest tightness, irritable stomach or peptic ulcers, frequent urination and musculoskeletal discomfort.

- **Keywords:** Questionnaire; Call center; Job stress; Health complaints

S. Warming, D.H. Precht, P. Suadicani, N.E. Ebbehøj. *Musculoskeletal complaints among nurses related to patient handling tasks and psychosocial factors – Based on logbook registrations*. S. 569-576.

The aims were to evaluate the inter-method reliability of a registration sheet for patient handling tasks, to study the day-to-day variation of musculoskeletal complaints (MSC) and to examine whether patient handling tasks and psychosocial factors were associated with MSC. Nurses (n = 148) fulfilled logbooks for three consecutive working days followed by a day off. Low back pain (LBP), neck/shoulder pain (NSP), knee pain (KP), psychosocial factors (time pressure, stress, conscience of the quality of work) and patient transfers and care tasks were reported. The logbook was reliable for both transfer and care tasks. The numbers of nurses reporting MSC and the level of pain increased significantly during the three working days (15%–30% and 17%–37%, respectively) and

decreased on the day off. Stress and transfer task were associated with LPB and transfer tasks were associated with KP. Our results confirm a relationship between work factors and MSC and indicate that logs could be one way to obtain a better understanding of the complex interaction of various nursing working conditions in relation to MSC.

- **Keywords:** Physical workload; Low back pain; Neck/shoulder pain; Knee pain; Stress

Xiaoming Qian, Jintu Fan. *A quasi-physical model for predicting the thermal insulation and moisture vapour resistance of clothing*. S. 577-590.

Based on the improved understanding of the effects of wind and walking motion on the thermal insulation and moisture vapour resistance of clothing induced by air ventilation in the clothing system, a new model has been derived based on fundamental mechanisms of heat and mass transfer, which include conduction, diffusion, radiation and natural convection, wind penetration and air ventilation. The model predicts thermal insulation of clothing under body movement and windy conditions from the thermal insulation of clothing measured when the person is standing in the still air. The effects of clothing characteristics such as fabric air permeability, garment style, garment fitting and construction have been considered in the model through the key prediction parameters. With the new model, an improved prediction accuracy is achieved with a percentage of fit being as high as 0.96.

- **Keywords:** Thermal insulation; Moisture vapour resistance; Mechanisms of heat and mass transfer; Prediction model; Ventilation; Clothing physical characteristics

Fu-Lin Chang, Yih-Min Sun, Kao-Hsing Chuang, Der-Jen Hsu. *Work fatigue and physiological symptoms in different occupations of high-elevation construction workers*. S. 591-596.

The objective of this study is to investigate whether work fatigue and physiological symptoms that high-elevation construction workers experience would be affected by the occupations. Questionnaires of demographic data and subjective fatigue symptoms as well as some physiological measurements were carried out, pre- and post-shift, on scaffolders, steel fixers, formworkers, electrician-plumbers, concreters and miscellaneous workers at a high-rise building construction site. This study found that some subjective fatigue symptoms coincide with the life style of some workers and that the extent of fatigue symptoms and physiological strains varies among different occupations of construction workers. Scaffolders, steel fixers and formworkers are categorized as physically demanding fatigue type of workers, while concreters, electrician-plumbers and miscellaneous workers as general type. The prevalence and occurrence of subjective fatigue symptoms indicate high-elevation workers have more complaints of "projection of physical impairment" than "drowsiness and dullness" and "difficulty in concentration". Some unexpected changes (i.e., post-shift measurements are greater than pre-shift ones) in some strength tests in scaffolders and concreters were consistent with the observations of how they exercised their bodies during work shift. Considerable variation of average heart rate among occupations was found, with scaffolders the highest and concreters the lowest. This study concludes that questionnaires of subjective fatigue symptoms and some physiological measurements can be used as indicators to predict the extent of strains or hazards which construction workers encounter. In terms of management program of safety and health, more attention should be paid to those physically demanding workers, such as scaffolders, workers with lower sense of safety and health, such as miscellaneous workers, and workers with older age, such as concreters.

- **Keywords:** Work fatigue; Subjective fatigue symptom; High-elevation construction workers

Matthew L. Bolton, Ellen J. Bass. *Comparing perceptual judgment and subjective measures of spatial awareness*. S. 597-607.

Spatial awareness is important in domains where safety hinges on human operators keeping track of the relative locations of objects in the environment. While a variety of subjective and judgment-based measures have been used to evaluate spatial awareness, none have probed all three of its levels: (1) identification of environmental objects, (2) their current locations relative to the operator, and (3) their relative positions over time. This work compares new judgment-based measures of spatial awareness that probe all three levels of spatial awareness to conventional subjective measures. In the evaluation of 14 configurations of Synthetic Vision Systems head down displays (seven terrain textures and two Geometric Fields of View (GFOVs)), 18 pilots made four types of judgments (relative angle, distance, height, and abeam time) regarding the location of terrain points displayed in 112 5-s, non-interactive simulations. They also provided subjective demand, awareness, clutter, SA-SWORD, and preferred GFOV measures. Correlation analyses revealed that displays that received higher awareness and SA-SWORD subjective ratings were associated with smaller errors in abeam time judgments and, for SA-SWORD, smaller errors in relative distance judgments. Thus SA-SWORD provides insight into level 2 spatial awareness and both SA-SWORD and awareness provide insight into level 3 spatial awareness. ANOVA and χ^2 analyses revealed comparable results between display configurations that produced the minimum error in judgments and those recommended by the awareness, SA-SWORD, and preferred GFOV measures.

- **Keywords:** Spatial awareness; Subjective measures; Perspective judgments

Sue Hignett, Jun Lu. *An investigation of the use of health building notes by UK healthcare building designers*. S. 608-616.Building design in the healthcare industry presents a complex architectural challenge. This paper reports a qualitative study to investigate the use of building design guidance by healthcare architects and planners in the United Kingdom. Sixteen architects, healthcare planners and facilities managers participated in 11 group and individual interviews. The data were analysed using NVivo2, resulting in three main themes: changes in the design culture over 20 years for the context of guidance use; quality of the evidence base to support the guidance; and future guidance needs to include patient expectations, new building techniques and generic room templates. The use of guidance was variable, with some participants seeing a clear role for new (more standardised) guidance in the future, whereas others were more concerned about loss of design freedom. Two clear roles for ergonomics were identified to: (1) facilitate the participation of patients and clinicians in the design process; and (2) generate new research evidence with respect to spatial requirements for clinical activities to support standardisation. These recommendations pertain specifically to healthcare facility design for the National Health Service in the UK.

- **Keywords:** Hospital design; Architecture; Design culture; User participation; Evidence-based medicine

Stephen H.M. Brown, Diane E. Grondin, Jim R. Potvin. *Strength limitations to proper child safety seat installation : implications for child safety.* S. 617-621.

A majority of child safety restraints are misused in some manner, often leading to an increased risk of serious injury or death. It is possible that at least some instances of misuse are the result of biomechanical limitations during the installation process. Twenty-seven adult participants were trained and then monitored in three stages of child

safety seat installation. All installations were done with an identical restraint system in the rear bench seat of a mocked-up minivan. EMG of 10 muscles, as well as trunk, shoulder, and wrist postures were analyzed. Peak maximum efforts were often required of the trunk extensor, forearm, and anterior shoulder muscles during the installation process. Routing and tightening of the seatbelt, as well as placing and securing the child into the seat were observed to be particularly difficult tasks. Many portions of the child safety seat installation process were found to be very physically demanding; some individuals may not be capable of performing these tasks correctly, thereby putting the child at greater risk in the motor vehicle.

- **Keywords:** Child safety; Biomechanics; Motor vehicle accident; Restraint systems

Miroslav Demić, Jovanka Lukić. *Investigation of the transmission of fore and aft vibration through the human body*. S. 622-629.

Understanding the behavior of human body under the influence of vibration is of great importance for the optimal motor vehicle system design. Therefore, great efforts are being done in order to discover as many information about the influence of vibration on human body as possible. So far the references show that the major scientific attention has been paid to vertical vibration, although intensive research has been performed lately on the other sorts of excitation. In this paper, the results of the investigation of behavior of human body, in seated position, under the influence of random fore and aft vibration are shown. The investigation is performed by the use of an electro-hydraulic simulator, on a group of 30 healthy male occupants. Experiments are performed in order to give results to improve human body modeling in driving conditions. Excitation amplitudes (1.75 and 2.25 m/s^2 rms) and seat backrest conditions (with and without inclination) were varied. Data results are analyzed by partial coherence and transfer functions. Analyses have been performed and results are given in detail. The results obtained have shown that the human body under the influence of random excitations behaves as a non-linear system and its response depends on spatial position. Obtained results give necessary data to define structure and parameters of human biodynamic model with respect to different excitation and seat backrest position.

- **Keywords:** Human; Fore and aft vibration; Partial coherence function; Transfer functions

Shuh-Ping Sun, Yi-Jiun Chou, Chun-Chia Sue. *Classification and mass production technique for three-quarter shoe insoles using non-weight-bearing plantar shapes*. S. 630-635.

We have developed a technique for the mass production and classification of three-quarter shoe insoles via a 3D anthropometric measurement of full-size non-weight-bearing plantar shapes. The plantar shapes of fifty 40–60-year-old adults from Taiwan were categorized and, in conjunction with commercially available flat or leisure shoe models, three-quarter shoe-insole models were generated using a CAD system. Applying a rapid prototype system, these models were then used to provide the parameters for manufacturing the shoe insoles. The insoles developed in this study have been classified into S, M and L types that offer user-friendly options for foot-care providers. We concluded that these insoles can mate tightly with the foot arch and disperse the pressure in the heel and forefoot over the foot arch. Thus, practically, the pressure difference over the plantar region can be minimised, and the user can experience comfort when wearing flat or leisure shoes.

- **Keywords:** 3D anthropometric measurement; Shoe insoles; Rapid prototyping

Guy H. Walker, Neville A. Stanton, Rebecca Stewart, Daniel Jenkins, Linda Wells, Paul Salmon, Chris Baber. *Using an integrated methods*

***approach to analyse the emergent properties of military command and control*. S. 636-647.**

This paper applies the event analysis for systemic teamwork (EAST) method to an example of military command and control. EAST offers a way to describe system level emergent properties that arise from the complex interactions of system components (human and technical). These are described using an integrated methods approach and modelled using Task, Social and Propositional networks. The current article is divided into three parts: a brief description of the military command and control context, a brief description of the EAST method, and a more in depth presentation of the analysis outcomes. The emergent properties of the military scenario relate to the degree of system reconfigurability, systems level situational awareness and the role of mediating technology. The findings are compared with similar analyses undertaken in civilian domains, in which the latest developments in command and control, under the aegis of Network Enabled Capability (NEC), are already in place.

- **Keywords:** C4I; EAST method; NEC; Situational awareness; Teamwork; Communications

Marianella Chamorro-Koc, Vesna Popovic, Michael Emmison. *Human experience and product usability : principles to assist the design of user–product interactions*. S. 648-656.

This paper introduces research that investigates how human experience influences people's understandings of product usability. It describes an experiment that employs visual representation of concepts to elicit participants' ideas of a product's use. Results from the experiment lead to the identification of relationships between human experience, knowledge, and context-of-use – relationships that influence designers' and users' concepts of product usability. These relationships are translated into design principles that inform the design activity with respect to the aspects of experience that trigger people's understanding of a product's use. A design tool (ECEDT) is devised to aid designers in the application of these principles. This tool is then trialled in the context of a design task in order to verify applicability of the findings.

- **Keywords:** Product design; Experience; Context-of-use

Donald O. Dusenberry, Howard Simpson, Steven J. DelloRusso. *Effect of handrail shape on graspability*. S. 657-669.

This paper summarizes research performed to evaluate the impact of handrail profile dimensions on graspability. It reports on research performed to determine the forces that stairway users exert on handrails when they fall, tests demonstrating the forces persons with various hand sizes can exert on handrails with different profiles, and comparisons of the probability of loss of grip by stairway users when they attempt to arrest a fall by grasping a handrail. The recommendations based on this work include specific definitions of the shapes of handrails that are deemed to be sufficiently graspable to constitute functional handrails.

- **Keywords:** Handrail graspability; Stairway falls; Handrail profiles; Handrail research

Juergen Sauer, Andreas Sonderegger. *The influence of prototype fidelity and aesthetics of design in usability tests : effects on user behaviour, subjective evaluation and emotion*. S. 670-677.

An empirical study examined the impact of prototype fidelity on user behaviour, subjective user evaluation and emotion. The independent factors of prototype fidelity (paper prototype, computer prototype, fully operational appliance) and aesthetics of design (high vs. moderate) were varied in a between-subjects design. The 60 participants of the experiment were asked to complete two typical tasks of mobile phone usage: sending a text message and suppressing a phone number. Both performance data and a number of subjective measures were recorded. The results suggested that task completion time may be overestimated when a computer prototype is being used. Furthermore, users appeared to compensate for deficiencies in aesthetic design by overrating the aesthetic qualities of reduced fidelity prototypes. Finally, user emotions were more positively affected by the operation of the more attractive mobile phone than by the less appealing one.

- **Keywords:** Usability test; Prototype fidelity; Aesthetics; Mobile phone

Guy H. Walker, Neville A. Stanton, Tara A. Kazi, Paul M. Salmon, Daniel P. Jenkins. *Does advanced driver training improve situational awareness?* S. 678-687.

Over 70 years of experiential evidence suggests that a specific form of advanced driver training, one based on an explicit system of car control, improves driver situation awareness (SA). Five experimental hypotheses are developed. They propose that advanced driving should increase the number of information elements in the driver's working memory, increase the interconnection between those elements, increase the amount of 'new' information in memory as well as the prominence of existing information, and that finally, it should stimulate behaviours that help drivers evolve better situations to be aware of. An approach to SA based on Neisser's perceptual cycle theory is anchored to a network based methodology. This is applied within the context of a longitudinal on-road study involving three groups of 25 drivers, all of whom were measured pre- and post-intervention. One experimental group was subject to advanced driver training and two further groups provided control for time and for being accompanied whilst driving. Empirical support is found for all five hypotheses. Advanced driving does improve driver SA but not necessarily in the way that existing situation focused, closed loop models of the concept might predict.

- **Keywords:** Advanced driving; Post-licensure; Situation awareness; Expert knowledge; Networks

David O'Hare, Neil Stenhouse. *Under the weather : an evaluation of different modes of presenting meteorological information for pilots*. S. 688-693.

Understanding current and forecast weather conditions for a planned route of flight is vital for general aviation (GA) pilots. Weather information can be obtained from multiple sources and in multiple formats, ranging from abbreviated code provided by aviation weather forecasters to animated graphical displays available on TV and the Internet. The present study investigated the effectiveness of graphical displays of meteorological information. A commercially available graphical display was ergonomically redesigned and the original and redesigned displays were compared with an ordinary text statement. Recall of information was significantly affected by display type. Comparisons showed the ergonomically redesigned display to be superior to the ordinary text statement. Performance was affected by participants' general level of familiarity with evaluating data displays as measured by their area of study (sciences or humanities). The generalizability of the results to the pilot population is discussed.

- **Keywords:** Displays; Graphics; Pilots

S.D. Baulk, A. Fletcher, K.J. Kandelaars, D. Dawson, G.D. Roach. *A field study of sleep and fatigue in a regular rotating 12-h shift system*. S. 694-698.

The aim of this study was to examine a regular rotating 12-h shift system (2D2N4Off) at an Australian Smelter. Sleep behavior, subjective fatigue and neurobehavioral performance were investigated over a 14-day period for 20 employees. Activity monitors, sleep/wake diaries, and 5-min psychomotor vigilance tasks were used. Sleep data showed differences between day and night shifts. While sleep prior to night1 was increased relative to day shifts, a reduced sleep length carried into the period leading to night2. Total wakefulness at the end of shift, and subjective fatigue were increased for night shifts, particularly night1. Decrements in performance data supported these findings. Both *prior wakefulness* and *prior sleep* are important in a 12-h shift system. Employees may "sleep in" after day shifts, rather than taking extra sleep prior to night work. Thus, sleep between day and night shifts is based on *recovery* rather than *preparation*.

- **Keywords:** Performance; Shiftwork; Sleep

Ling Rothrock, Ayala Cohen, Jing Yin, Hari Thiruvengada, Inbal Nahum-Shani. *Analyses of team performance in a dynamic task environment*. S. 699-706.

Teamwork, a central component of team research, is not readily observable and must be inferred from the manner in which teams operate. Of particular interest is the measurement and evaluation of teamwork. The goal of this paper is to explore the assessment of team data using a temporal accuracy measure called the Relative Accuracy Index (RAI). For the statistical analysis, the generalized mixed model was applied. This model is applicable for binomial data and takes into account the correlation structure within team members. We describe the statistical procedure in detail, aiming to guide researchers who encounter similar problems. Using our statistical analysis, we found that participants whose training focused on coordination activities outperformed those whose training did not. Moreover, we found that workload stress accentuates the difference.

- **Keywords:** Teamwork analysis; Temporal accuracy; Relative accuracy index; Generalized mixed model

Tatiana de Oliveira Sato, Helenice Jane Cote Gil Coury. *Evaluation of musculoskeletal health outcomes in the context of job rotation and multifunctional jobs*. S. 707-712.

Higher physical demands at work are associated with health outcomes such as discomfort, disorders and sick leave. Variations in work exposure patterns, introduced by multifunctional jobs and ergonomic interventions, bring confounders into the complex relation between occupational risks and musculoskeletal disorders. This study compared whole-body rating of perceived exertion (RPE), discomfort, ergonomic workplace analysis (EWA) and sick leave due to musculoskeletal disorders, among workers exposed to diversified work. The results showed that EWA performed by the observer differed from workers' ratings. There were no differences between groups of workers taking or not taking sick leave regarding RPE and discomfort at their current workstations. Workers significantly discriminated between progressive workload levels, and RPE scores for specific tasks were nonlinear during shifts. These differences might be associated with exposure variability. Thus, in the context of diversified work, the RPE scale seems more appropriate for evaluating acute effects of work variability.

- **Keywords:** Industrial rationalisation; Exposure diversity; Health outcomes

Margarita Anastassova, Jean-Marie Burkhardt. *Automotive technicians' training as a community-of-pr*actice : implications for the design of an augmented reality teaching aid. S. 713-721.

The paper presents an ergonomic analysis carried out in the early phases of an R&D project. The purpose was to investigate the functioning of today's Automotive Service Technicians (ASTs) training in order to inform the design of an Augmented Reality (AR) teaching aid. The first part of the paper presents a literature review of some major problems encountered by ASTs today. The benefits of AR as technological aid are also introduced. Then, the methodology and the results of two case studies are presented. The first study is based on interviews with trainers and trainees; the second one on observations in real training settings. The results support the assumption that today's ASTs' training could be regarded as a community-of-practice (CoP). Therefore, AR could be useful as a collaboration tool, offering a shared virtual representation of real vehicle's parts, which are normally invisible unless dismantled (e.g. the parts of a hydraulic automatic transmission). We conclude on the methods and the technologies to support the automotive CoP.

- **Keywords:** Augmented reality; Automotive maintenance; Community-of-practice

Chieh-Hsin Tang, Wu-Tai Wu, Ching-Yuan Lin. *Using virtual reality to determine how emergency signs facilitate way-finding*. S. 722-730.

In this study, virtual reality was the tool used to construct an experimental space. Three scenarios – one without emergency signs, another with an old-version emergency sign, and the third with a new-version emergency sign – were created, after which 107 subjects, divided into three groups, engaged in an emergency escape game to determine if and how various emergency signs aid in way-finding in the event of an emergency. Under the presupposition that the minimum time needed for an emergency escape without any mistake occurring was 40 s, we found that the average way-finding time in the scenario without any emergency signs was 123.8 s, for the scenario with the new-version signs 84.8 s, and for the scenario with the old-version signs 75.6 s; statistically, this demonstrated that the absence of signs results in slower escape than either old signs ($p = 0.001$) or new signs ($p = 0.005$). These findings indicate that signs do help way-finding greatly. Males were found to exhibit better way-finding skills than females ($p < 0.001$). Construction workers and fire safety personnel, as a combined group, did not fare better than others with less presumed prior experience with building plans or emergency exit procedures. In addition, when faced with both an emergency direction sign and an exit door, almost half of the subjects (42% of the participants) were chosen to take the door instead of following the direction posted on the sign. Finally, we found that, at T-intersections, the majority of participants (60%) chose to turn left versus right.

- **Keywords:** Virtual reality; Way-finding; Emergency signs; Simulation

Yasemin Afacan, Cigdem Erbug. *An interdisciplinary heuristic evaluation method for universal building design*. S. 731-744.

This study highlights how heuristic evaluation as a usability evaluation method can feed into current building design practice to conform to universal design principles. It provides a definition of universal usability that is applicable to an architectural design context. It takes the seven universal design principles as a set of heuristics and applies an iterative sequence of heuristic evaluation in a shopping mall, aiming to achieve a cost-effective evaluation process. The evaluation was composed of three consecutive sessions. First, five evaluators from different professions were interviewed regarding the construction drawings in terms of universal design principles. Then, each evaluator was asked to

perform the predefined task scenarios. In subsequent interviews, the evaluators were asked to re-analyze the construction drawings. The results showed that heuristic evaluation could successfully integrate universal usability into current building design practice in two ways: (i) it promoted an iterative evaluation process combined with multi-sessions rather than relying on one evaluator and on one evaluation session to find the maximum number of usability problems, and (ii) it highlighted the necessity of an interdisciplinary ad hoc committee regarding the heuristic abilities of each profession. A multi-session and interdisciplinary heuristic evaluation method can save both the project budget and the required time, while ensuring a reduced error rate for the universal usage of the built environments.

- **Keywords:** Heuristic evaluation method; Universal design; Universal usability; Cost-effectiveness; Building design

Jan Dul, W. Patrick Neumann. *Ergonomics contributions to company strategies*. S. 745-752.

Managers usually associate ergonomics with occupational health and safety and related legislation, not with business performance. In many companies, these decision makers seem not to be positively motivated to apply ergonomics for reasons of improving health and safety. In order to strengthen the position of ergonomics and ergonomists in the business and management world, we discuss company strategies and business goals to which ergonomics could contribute. Conceptual models are presented and examples are given to illustrate: (1) the present situation in which ergonomics is not part of regular planning and control cycles in organizations to ensure business performance; and (2) the desired situation in which ergonomics is an integrated part of strategy formulation and implementation. In order to realize the desired situation, considerable changes must take place within the ergonomics research, education and practice community by moving from a health ergonomics paradigm to a business ergonomics paradigm, without losing the health and safety goals.

- **Keywords:** Corporate strategy; System performance; Paradigm shift

Anne Miller, Carlos Scheinkestel, Cathie Steele. *The effects of clinical information presentation on physicians' and nurses' decision-making in ICUs*. S. 753-761.

This research evaluated physicians' agreement about patients' diagnoses and nurses' ability to detect patient change using traditional charts (TC) and a work domain analysis-based paper prototype (PP) and also sought to determine whether differences persisted when the PP was represented as an electronic prototype (EP). Nurses' change detection improved using the PP and EP compared to TC (PP vs TC, $t_{(df=6)} = 1.94$, $p < 0.03$; EP vs TC, $t_{(df=6)} = 3.14$, $p < 0.01$) and detection was better using the EP compared with the PP ($t_{(df=6)} = 5.96$, $p < 0.001$). Physicians were more likely to agree about failed physiological systems using the EP compared with the PP ($t_{(df=10)} = 3.14$, $p < 0.01$), but agreement about patient diagnoses was higher using the PP compared with the EP ($t_{(df=10)} = 2.23$; $p < 0.02$). These results are attributed to information grouping around physiological functions and the direct association of cause-and-effect relations in clinical information design.

- **Keywords:** Patient change detection; Diagnostic agreement; Clinical information systems

Ochae Kwon, Kihyo Jung, Heecheon You, Hee-Eun Kim. *Determination of key dimensions for a glove sizing system by analyzing the relationships between hand dimensions*. S. 762-766.

The present study identified key dimensions for the development of a glove sizing system by analyzing the relationships between hand dimensions and demonstrated the construction process of glove sizing systems based on the selected key dimensions. Three hand dimensions (HL: hand length; HC: hand circumference; HB: hand breadth) were selected as the candidates of glove key dimensions by surveying the literature and industry practices of glove sizing systems. Of the key dimension candidates, HL and HC were selected by examining the results of correlation and multiple regression analyses on the 1988 US Army hand anthropometric data. A cross-tabulation of HL and HC with an interval length of 1.3 cm was constructed for each gender and the corresponding lengths and circumferences of cells covering more than 2% of the population were used to provide glove sizing parameters. It was identified that the glove sizing system for males is different from that for females and has more size categories.

- **Keywords:** Glove sizing system; Key dimensions; Correlation analysis; Multiple regression analysis; Cross-tabulation

Chi-Yuang Yu, Hsin-Hung Tu. *Foot surface area database and estimation formula*. S. 767-774.

The purpose of this study is to establish a foot surface area (FSA) database and estimation formula based on 3-D foot scan data. For each gender, 135 subjects stratified in five statures and three body weights were drawn. The foot was measured using a high-resolution 3-D foot scanner, of which the precision and accuracy is within 1%. The FSA was computed by the triangular mesh summation method and five 1-D foot measurements were extracted automatically to be used as candidate estimators for FSA estimation formula. The results of the FSA measurements are tabulated on fifteen strata for the Male, the Female and the Total (the two genders combined). The comparison of these FSA measurements with previous studies shows that previous studies underestimated the FSA approximately 4.06% for the Total (for the Male, 6.93%; for the Female, 0.82%). Regression analyses using these five 1-D foot measurements were performed. The results show that foot-length and ball-girth are effective estimators of FSA for the total (FSA = 1.043 × foot-length × ball-girth, R^2 = 95.4%). A test on the necessity of gender-specific formula indicated that no gender-specific formula is needed, and the formula for the total is good for both genders.

- **Keywords:** Foot surface area; Body surface area; FSA estimation formula; BSA estimation formula

Jan Johansson, Lena Abrahamsson. *The good work : a Swedish trade union vision in the shadow of lean production*. S. 775-780.

"The Good Work" (*Det goda arbetet*) was established as a highly praised and established concept in the Swedish working life debate in the middle of the 1980s. In this paper, we are going to discuss the concept in relation to the massive introduction of lean production in Swedish industry. The aim of this paper is to restore the theory of the good work into the industrial society of today. We will search for a model for 'good work' in balance between the demands from production and good conditions for a learning environment. The theoretical base for this paper will be found in both organisational research and research on production technology systems. We identify three strong trends in Swedish industrial companies giving both pitfalls and possibilities for the good work; the learning focus as a way to increase productivity and improve working conditions; Lean Production in most cases imply narrow short-cyclic work tasks; and the global market that reduces national discretion. As a result, we formulate a new set of criteria for "the good work".

- **Keywords:** Work environment; Work organisation; Lean production

Christopher S. Pan, Sharon Chiou, Tsui-Ying Kau, Amit Bhattacharya, Doug Ammons. *Effects of foot placement on postural stability of construction workers on stilts*. S. 781-789.

Stilts are elevated tools that are frequently used by construction workers to raise workers 18–40 inches above the ground. The objective of this laboratory study was to evaluate the potential loss of postural stability associated with the use of stilts in various foot placements. Twenty construction workers with at least 1 year of experience in the use of stilts participated in this study. One Kistler™ force platform was used to collect kinetic data. Participants were tested under six-foot-placement conditions. These 6 experimental conditions were statically tested under all combinations of 3 levels of elevation: 0″ (no stilts), 24″ stilt height and 40″ stilt height. SAS mixed procedure was used to evaluate the effect of different experimental conditions. The results of the multivariate analysis of variance (MANOVA) and repeated measures of univariate analyses of variance (ANOVAs) demonstrated that stilt height, foot-placement direction, and foot-placement width all had significant effects on the whole-body postural stability. This study found that the higher the stilts were elevated, the greater the postural instability. A stance position with one foot placed forward of the other foot produced greater postural instability than a position with the feet parallel and directly beneath the body. This study found that placement of the feet parallel and directly beneath the body, with the feet positioned a half shoulder width apart, caused a greater amount of postural sway and instability than one and one-and-half shoulder width. This study also found that construction workers using the stilts could perceive the likely postural instability due to the change in foot placements.

- **Keywords:** Stilts; Postural instability; Foot placements; Fall injuries

Minna Päivinen, Tanja Heinimaa. *The usability and ergonomics of axes*. S. 790-796.

This study evaluated the ergonomics and usability of axes. Several methods were used, namely measurement of impact velocity, the determination of kinetic energy, splitting performance tests, durability tests of blades and handles, and user trials. The mean velocity used in the striking was 9.6 m/s (8.9–10.3 m/s, SD 1.5). In the durability tests, the blades withstood the test reasonably well. In the bending tests, there were differences in the durability of the handles, which related to their material. A wide variation in the durability of the axe handles was also observed. User trials were conducted to evaluate the various features of the axes.

- **Keywords:** Hand tool; Axe; Design; Evaluation

Lars Hanson, Lena Sperling, Gunvor Gard, Staffan Ipsen, Cindy Olivares Vergara. *Swedish anthropometrics for product and workplace design*. S. 797-806.

The present study describes the anthropometrics of the Swedish workforce, aged 18–65, and compares the measurements with data collected four decades earlier. This anthropometric information is based on measurements of a total of 367 subjects, 105 males and 262 females. Of the 367 subjects, 268 responded to advertisements (Study A) and 99 were randomly selected from a community register (Study B). Subjects were scanned in four positions. Manual measuring equipment was used for hands, feet, head and stature. As differences between significant measurements in Studies A and B were negligible, the data were merged. Anthropometric descriptive statistics of women and men are presented for 43 body dimensions. Participants represent the Swedish population fairly well when compared with national statistics of stature and weight. Comparing new anthropometric data with old shows that the breadth, depth, height, and

length measurements of Swedes as well as weight have increased and that Swedish anthropometric homogeneity has decreased. The results indicate that there is a need to update ergonomic recommendations and adjust products and workplaces to the new information.

- **Keywords:** Anthropometrics; Body scanning; User representation; Sweden

Jianwei Niu, Zhizhong Li, Gavriel Salvendy. *Multi-resolution description of three-dimensional anthropometric data for design simplification*. S. 807-810.

Three-dimensional (3D) anthropometry can provide rich information for ergonomic product design with better safety and health considerations. To reduce computational load and model complexity in product design when using 3D anthropometric data, wavelet analysis is adopted in this paper to establish multi-resolution mathematical description of 3D anthropometric data. A proper resolution can be selected for design reference according to the application purpose. To examine the approximation errors under difference resolutions, 510 upper head, whole head, and face samples of Chinese young men have been analyzed. Descriptives of approximation errors under different resolutions are presented. These data can be used as resolution selection guide. The application of the multi-resolution method in product design is illustrated by two examples. *Relevance to industry*: multi-resolution description of 3D anthropometric data would facilitate the analysis of and design with 3D anthropometric data to improve fitting comfort. The error data under different resolutions provide important reference for resolution selection.

- **Keywords:** 3D anthropometric data; Wavelet analysis; Multi-resolution description; Fitting design

Shu-Wen Wu, Su-Fang Wu, Hong-Wei Liang, Zheng-Ting Wu, Sophia Huang. *Measuring factors affecting grip strength in a Taiwan Chinese population and a comparison with consolidated norms*. S. 811-815.

We inquire whether assessment of an individual's upper limb function may be improved by using specific regional norms rather than consolidated global norms. Grip strengths were measured in a sample of 482 adults across Taiwan, and compared with consolidated norms. To ensure comparable conditions, our procedures were those recommended by the American Society of Hand Therapists (ASHT). Overall the mean grip strength of our sample was significantly (male 25%, female 27%) lower than consolidated norms derived from largely Caucasian populations. We investigated variables that might relate to this divergence. Results of ANOVA and stepwise multiple regression analysis showed that gender, age and palm length were effective predictors in grip strength. A regression equation was derived. When other variables were matched, palm length appeared an important discriminating factor. Further anthropometric and socio-economic factors also need investigation. Specific regional norms should provide more accuracy for ergonomists and health workers assessing an individual's upper limb function, and may avoid errors in appraisal. This paper suggests grip strength values for Taiwan.

- **Keywords:** Grip strength; Grip span; Grip position; Palm length; Consolidated norm