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Neville A. Stanton, Guy H. Walker & Linda J. Sorensen. *It's a small world after all: contrasting hierarchical and edge networks in a simulated intelligence analysis task.* Pages 265-281.

This article presents the rationale behind an important enhancement to a socio-technical model of organisations and teams derived from military research. It combines this with empirical results which take advantage of these enhancements. In Part 1, a new theoretical legacy for the model is developed based on Ergonomics theories and insights. This allows team communications data to be plotted into the model and for it to demonstrate discriminate validity between alternative team structures. Part 2 presents multinational data from the Experimental Laboratory for Investigating Collaboration, Information-sharing, and Trust (ELICIT) community. It was surprising to see that teams in both traditional hierarchical command and control and networked 'peer-to-peer' organisations operate in broadly the same area of the model, a region occupied by networks of communication exhibiting 'small world' properties. Small world networks may be of considerable importance for the Ergonomics analysis of team organisation and performance.

Practitioner Summary: This article is themed around macro and systems Ergonomics, and examines the effects of command and control structures. Despite some differences in behaviour and measures of agility, when given the freedom to do so, participants organised themselves into a small world network. This network type has important and interesting implications for the Ergonomics design of teams and organisations.

- **Keywords:** command and control, organisation structure, networks, agility

Nadine Kakarot, Friedrich Mueller & Claudia Bassarak. *Activity–rest schedules in physically demanding work and the variation of responses with age.* Pages 282-294.

Workers in physically demanding occupations require work breaks to recover from exertion. In a laboratory setting, we investigated the impact of ergometer cycling for 7 h in two conditions with an identical total break time but with two different activity–rest schedules. We hypothesised that more frequent but shorter breaks lead to less psychophysical strain and its effects than do less frequent but longer breaks, particularly for older workers. Twenty-nine participants representing three different age groups were tested in both conditions. Heart rate, perceived exertion/tension and feelings of fatigue were assessed and used as dependent variables. Results indicate no general activity–rest

differences as well as no age-related differences of break effects under the condition of subjectively equal straining load. However, heart rate was found to be lower at some measurement points in the frequent-short-break condition and perceived exertion was lower in the infrequent-long-break condition.

Practitioner Summary: Design of activity–rest schedules in physically demanding occupations is a key issue in the prevention of strain and hence of interest to ergonomists. Our study suggests that breaks during physically demanding work have the same effect if they are frequent and short or infrequent and long, regardless of age.

- **Keywords:** activity–rest schedules, physical work, perceived exertion, aging workforces, heart rate

Afshin Samani, Andreas Holtermann, Karen Sjøgaard, Andreas Holtermann & Pascal Madeleine. *Following ergonomics guidelines decreases physical and cardiovascular workload during cleaning tasks.* Pages 295-307.

The aim was to investigate the effect of ergonomics guidelines on muscular activity, postural and cardiovascular load during cleaning. Eighteen cleaners performed 10 min of cleaning tasks in two locations; three min in a laboratory and seven min in a lecture room. All participants performed the task with or without focusing on ergonomics guidelines (ergonomics/non-ergonomics session). Bipolar surface electromyography was recorded bilaterally from upper trapezius and erector spinae muscles. A tri-axial accelerometer package was mounted on the low back (L5-S1) to measure postural changes, and the cardiovascular load was estimated by electrocardiogram. Ergonomics sessions resulted in lower muscular load, a more complex pattern of muscular activity, lower range of motion and angular velocity of the trunk as well as lower cardiovascular load compared with non-ergonomics sessions ($p < 0.05$). The study highlighted the multiple musculoskeletal and cardiovascular benefits of following ergonomics guidelines during cleaning tasks.

Practitioner Summary: This study investigated the effects of following instructive ergonomics guidelines during cleaning tasks (daily curriculum of cleaning including mopping, sweeping, changing trash bins and cleaning of desks and blackboards). Following the ergonomics guidelines reduces the general workload and induces a more complex pattern of muscular activity. The study contributes with novel knowledge concerning ergonomics guidelines and work techniques.

- **Keywords:** complexity, electromyography, inclinometry, heart rate variability

Wen-Ruey Chang, Chien-Chi Chang & Simon Matz. *Comparison of different methods to extract the required coefficient of friction for level walking.* Pages 308-315.

The required coefficient of friction (RCOF) is an important predictor for slip incidents. Despite the wide use of the RCOF there is no standardised method for identifying the RCOF from ground reaction forces. This article presents a comparison of the outcomes from seven different methods, derived from those reported in the literature, for identifying the RCOF from the same data. While commonly used methods are based on a normal force threshold, percentage of stance phase or time from heel contact, a newly introduced hybrid method is based on a combination of normal force, time and direction of increase in coefficient of friction. Although no major differences were found with these methods in more than half the strikes, significant differences were found in a significant portion of strikes. Potential problems with some of these methods were identified and discussed and they appear to be overcome by the hybrid method.

Practitioner Summary: No standard method exists for determining the required coefficient of friction (RCOF), an important predictor for slipping. In this study, RCOF values from a single data set, using various methods from the literature, differed considerably for a significant portion of strikes. A hybrid method may yield improved results.

- **Keywords:** required coefficient of friction, cross method comparison, human locomotion, friction demand

Katrina M. Simpson, Bridget J. Munro & Julie R. Steele. *Effects of prolonged load carriage on ground reaction forces, lower limb kinematics and spatio-temporal parameters in female recreational hikers.* Pages 316-326.

The effect of load carriage on female recreational hikers has received little attention. This study collected lower limb sagittal plane kinematic, spatio-temporal and ground reaction force (GRF) data from 15 female hikers carrying four loads (0%, 20%, 30% and 40% body weight (BW)) over 8 km. Increasing load resulted in a proportional increase in GRF up to 30% BW, increased stance time, and greater mediolateral impulse with 30% and 40% BW. Also seen were decreased velocity and cadence and increased double support and knee flexion when carrying load compared to no load. Increased distance resulted in increased knee flexion and ankle plantar flexion at initial foot-ground contact. It was concluded that, as load mass and distance increased, female hikers modified their gait to attenuate the lower limb impact forces. When carrying 30% and 40% BW loads, however, the changes aimed at attenuating the higher GRF may result in a less stable gait.

Practitioner Summary: Limited research has investigated the biomechanical responses of female recreational hikers to prolonged load carriage. This study provides a better understanding of the effects of increasing load on lower limb kinematics, spatio-temporal parameters and the GRF generated by female hikers during prolonged load carriage. The results have implications for the development of load carriage guidelines to minimise the risk of injury to females who carry backpacks and to improve performance for this population.

- **Keywords:** load carriage, ground reaction force, gait, female, kinematics

Baiduri Widanarko, Stephen Legg, Mark Stevenson, Jason Devereux, Amanda Eng, Andrea't Mannetje, Soo Cheng & Neil Pearce. *Gender differences in work-related risk factors associated with low back symptoms.* Pages 327-342.

The prevalence of low back symptoms (LBS) in many working populations is high and differences in prevalence between genders are inconsistent. However, gender-specific risk factors for LBS have seldom been examined. Hence, the aim of the present study was to indicate gender-specific LBS risk factors. A sample of 3003 people was interviewed by telephone to get information about current workplace exposure and LBS. The risk of LBS for the whole population increased with work in awkward/tiring positions (OR 1.37, 95% CI 1.12–1.68) and very/extremely stressful jobs (OR 1.46, 95% CI 1.05–2.03). None of the explanatory variables were significantly associated with LBS for males but working in awkward/tiring positions (OR 1.51, 95% CI 1.04–2.20), dissatisfaction with contact and cooperation with management (OR 1.68, 95% CI 1.02–2.78) and finding their job to be very/extremely stressful (OR 2.27, 95% CI 1.46–3.52) were significantly associated with LBS for females. Interventions to reduce LBS in workplaces should focus on reducing working in awkward/tiring positions, improving contact and cooperation with management, and reducing stressful jobs, especially amongst females.

Practitioner Summary: Strategies to prevent or reduce LBS should focus on reducing exposure to awkward or tiring positions at work, improving contact and cooperation with management, and reducing stressful jobs, especially for females.

- **Keywords:** back pain, gender, Nordic questionnaire, *organisational culture*, *psychosocial factor*

P.P.F.M. Kuijer, S.H. van Oostrom, K. Duijzer & J.H. van Dieën. *Maximum acceptable weight of lift reflects peak lumbosacral extension moments in a functional capacity evaluation test using free style, stoop and squat lifting.* Pages 343-349.

It is unclear whether the maximum acceptable weight of lift (MAWL), a common psychophysical method, reflects joint kinetics when different lifting techniques are employed. In a within-participants study ($n = 12$), participants performed three lifting techniques – free style, stoop and squat lifting from knee to waist level – using the same dynamic functional capacity evaluation lifting test to assess MAWL and to calculate low back and knee kinetics. We assessed which knee and back kinetic parameters increased with the load mass lifted, and whether the magnitudes of the kinetic parameters were consistent across techniques when lifting MAWL. MAWL was significantly different between techniques ($p = 0.03$). The peak lumbosacral extension moment met both criteria: it had the highest association with the load masses lifted ($r > 0.9$) and was most consistent between the three techniques when lifting MAWL (ICC = 0.87). In conclusion, MAWL reflects the lumbosacral extension moment across free style, stoop and squat lifting in healthy young males, but the relation between the load mass lifted and lumbosacral extension moment is different between techniques.

Practitioner Summary: Tests of maximum acceptable weight of lift (MAWL) from knee to waist height are used to assess work capacity of individuals with low-back disorders. This article shows that the MAWL reflects the lumbosacral extension moment across free style, stoop and squat lifting in healthy young males, but the relation between the load mass lifted and lumbosacral extension moment is different between techniques. This suggests that standardisation of lifting technique used in tests of the MAWL would be indicated if the aim is to assess the capacity of the low back.

- **Keywords:** biomechanics, physical work capacity, manual handling, low-back pain

Mahmoud Rezagholi, Svend Erik Mathiassen & Per Liv. *Cost efficiency comparison of four video-based techniques for assessing upper arm postures.* Pages 350-360.

Many video-based techniques for assessing postures at work have been developed. Choosing the most appropriate technique should be based on an evaluation of different alternatives in terms of their ability to produce posture information at low input costs, i.e. their cost efficiency. This study compared four video-based techniques for assessing upper arm postures, using cost and error data from an investigation on hairdressers. Labour costs associated with the posture assessments from the video recordings were the dominant factor in the cost efficiency comparison. Thus, a work sampling technique associated with relatively large errors appeared, in general, to be the most cost-efficient because it was labour-saving. Measurement bias and other costs than labour cost for posture assessment influenced the ranking and economic evaluation of techniques, as did the applied measurement strategy, i.e. the numbers of video recordings and repeated assessments of them.

Practitioner Summary: The cost efficiency of four video-based techniques for assessing upper arm postures was compared. Work sampling techniques were in general more cost

efficient than continuous observations since they were labour-saving. Whilst a labour cost dominated the comparison, 'hidden costs', bias and measurement strategy also influenced this dominance.

- **Keywords:** precision, bias, input costs, measurement strategy, model specification

Jia-Hua Lin, Raymond W. McGorry & Rammohan V. Maikala. *The effects of joint torque, pace and work:rest ratio on powered hand tool operations.* Pages 361-370.

Repetitive use of hand-held power tools is associated with work-related upper extremity musculoskeletal disorders. Using a pneumatic nutrunner, 21 men completed twelve 360 repetitive fastener-driving sessions on three joints (hard, soft and control) at slow and fast pace, and two different work:rest patterns. Handgrip force and perceived exertions were collected throughout each session. For the control joint, the mean grip force exerted was 39.6% of maximum voluntary exertion (MVE) whereas during hard and soft joint sessions it was 48.9% MVE and 56.9% MVE, respectively. Throughout each session, the grip force decreased, more while operating soft and hard joints as compared with the control joint (regression slope: -0.022 and -0.023 , compared with -0.007 N/drive, respectively), suggesting considerable upper extremity muscular effort by participants during torque buildup. Fast work pace resulted in higher average grip forces by participants but a greater decrease in the force as the session progressed. Providing rest breaks reduced perceived exertions. The findings gain additional knowledge for assembly task design to possibly reduce the hand/arm injury risks for the operator.

Practitioner Summary: Powered hand tools are widely used in assembly and manufacturing industries. However, the nature of their repetitive use on human operator biomechanical and perceptual responses is not fully understood. This study examined work-related risk factors such as joint torque, pace and work:rest ratios on powered hand tool performance.

- **Keywords:** industrial ergonomics, physical fatigue, operator workload, hand tools and interfaces, biomechanics

Céline McKeown. *Canine ergonomics: the science of working dogs.* Pages 371-372.