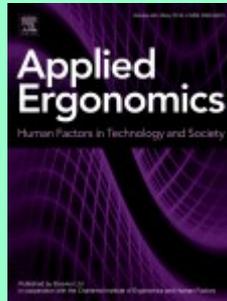


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Kerstin Nilsson. *A sustainable working life for all ages: The swAge-model.*

Background: Due to the demographic challenge in most countries it is important to consider making work life sustainable. A sustainable work life is of importance in all age groups when working life will be extended to a higher age. **Aim:** Towards a theoretical model with an impact on a sustainable working life for all ages, the swAge - model. **Method:** The theoretical model, the swAge-model, is developed based on grounded theory using qualitative studies, quantitative studies, intervention projects and literature reviews. **Result:** The swAge-model states the interactions between different ageing concepts; chronological, mental, biological and social ageing, and the nine areas of importance for individuals' work life participation. The model also states the four consideration areas whether individuals can and want to participate in an extended working life or not. The model also includes proposed measures at the organisation/enterprise level and at the society level based on the four activity areas at the individual level. **Conclusion:** The theoretical swAge-model describes how to reflect on working life and presents tools to extend work life in a sustainable way for older workers in modern society. The swAge-models' analysis and measure matrix is included as appendix 1. In the Nordic countries the theoretical model is use in the critical debate and as a tool for managers and authorities to make the working life sustainable for all ages.

- **Keywords:** Ageing; Older workers; Demography; Retirement; Prevention; Health; Work disease; Economic; Work environment; Working hours; Recreation; Age management; Skills and competence development; Motivation and work satisfaction; Family and leisure pursuits

Sandra Dorothee Starke, Chris Baber. *The effect of known decision support reliability on outcome quality and visual information foraging in joint decision making.*

Decision support systems (DSSs) are being woven into human workflows from aviation to medicine. In this study, we examine decision quality and visual information foraging for DSSs with different known reliability levels. Thirty-six participants completed a financial fraud detection task, first unsupported and then supported by a DSS which highlighted important information sources. Participants were randomly allocated to four cohorts, being informed that the system's reliability was 100%, 90%, 80% or undisclosed. Results showed that only a DSS known to be 100% reliable resulted in participants systematically following its suggestions, increasing the percentage of correct

classifications to a median of 100% while halving both, decision time and number of visually attended information sources. In all other conditions, the DSS had no effect on most visual sampling metrics, while decision quality of the human-DSS team was below the reliability level of the DSS. Knowledge of an even slightly unreliable system hence had a profound impact on joint decision making, with participants trusting their significantly worse performance more than the DSSs suggestions.

Linda M. Rose, Jörgen Eklund, Lena Nord Nilsson, Linda Barman, Carl M. Lind. *The RAMP package for MSD risk management in manual handling – A freely accessible tool, with website and training courses.*

In this paper the RAMP Package is presented with the objective to facilitate the application of the RAMP tool to systematically manage MSD risks. The package consists of the RAMP tool (Risk Assessment and Management tool for manual handling Proactively), the RAMP website, and free, globally available online, training courses (MOOCs). An Action module used for managing identified MSD risks is introduced. The tool, encompassing a wide range of risks, is applicable to the whole risk management process. Furthermore, RAMP is openly available for download, and free to use. The RAMP tool and training materials were developed using a participative iterative methodology including researchers and practitioners. RAMP was downloaded in 86 countries in the first 26 months since its' launch and over 2400 learners from high-, middle- and low-income countries have joined the MOOCs. The RAMP Package meets organisations' needs for an accessible, comprehensive risk assessment and management tool.

- **Keywords:** Dissemination strategy; MOOC (Massive open online course); Risk assessment; Ergonomics

Tracy Ross, Andrew May, Stuart A. Cockbill. [The personal and contextual factors that affect customer experience during rail service failures and the implications for service design.](#)

This paper: identifies personal and contextual factors that influence customer experience when service failures occur in rail transport; what is being conveyed through that factor (e.g. older age being used to convey vulnerability); and the implications for future service design. The results are from a thematic analysis of free-text rail passenger complaints (n = 516) reporting service failures that impacted on customer experience. The study differs from existing research on the pertinent personal and contextual factors for public transport service provision in that it: focuses on the passenger experience resulting from specific incidents (rather than evaluative, overall assessments of satisfaction), generates the factors inductively from the data (rather than a-priori) and uses detailed qualitative cases (rather than quantitative survey data). The findings (1) identify some similar factors to those used in previous research and uncover some new factors for both person and context, (2) provide an understanding of what they mean in terms of the passenger experience and (3) indicate how the factors might need to be measured if they are to be used by the rail industry. The paper concludes by using the outcome of an industry-based validation exercise to describe how the findings could be used in future rail services, namely: predicting where the customer experience is going to be sub-optimal, prioritising responses to particular circumstances, and designing services to better meet customer's needs. This exploratory research is timely, given the need for a more passenger-centric approach to service design and future developments such as smart-ticketing, which could potentially enable greater understanding of who is using the rail network and for what journeys.

- **Keywords:** Service design; Rail transit; Customer experience

Romain Martinez, Najoua Assila, Etienne Goubault, Mickaël Begon. *Sex differences in upper limb musculoskeletal biomechanics during a lifting task.*

Women experience higher prevalence of work-related upper limb musculoskeletal disorders compared to men. Previous studies have investigated the biological, kinematic and electromyographic sex-related differences during a lifting task but the actual differences in musculoskeletal loads remain unknown. We investigated the sex differences in three musculoskeletal indicators: the sum of muscle activations, the sum of muscle forces and the relative time spent beyond a shear-compression dislocation ratio. A musculoskeletal model was scaled on 20 women and 20 men lifting a 6 or 12kg box from hip to eye level. Women generated more muscle forces and activations than men, regardless of the lifted mass. Those differences occurred when the box was above shoulder level. In addition, women might spend more time beyond a shear-compression dislocation ratio. Our work suggests higher musculoskeletal loads among women compared to men during a lifting task, which could be the result of poor technique and strength difference.

- **Keywords:** Sex differences; Upper limb; Musculoskeletal modelling

Dominic Furniss, David Nelson, Ibrahim Habli, Sean White, Matthew Elliott, Nick Reynolds, Mark Sujjan. *Using FRAM to explore sources of performance variability in intravenous infusion administration in ICU: A non-normative approach to systems contradictions.*

Systems contradictions present challenges that need to be effectively managed, e.g. due to conflicting rules and advice, goal conflicts, and mismatches between demand and capacity. We apply FRAM (Functional Resonance Analysis Method) to intravenous infusion practices in an intensive care unit (ICU) to explore how tensions and contradictions are managed by people. A multi-disciplinary team including individuals from nursing, medical, pharmacy, safety, IT and human factors backgrounds contributed to this analysis. A FRAM model investigation resulting in seven functional areas are described. A tabular analysis highlights significant areas of performance variability, e.g. administering medication before a prescription, prioritising drugs, different degrees of double checking and using sites showing early signs of infection for intravenous access. Our FRAM analysis has been non-normative: performance variability is not necessarily wanted or unwanted, it is merely necessary where system contradictions cannot be easily resolved and so adaptive capacity is required to cope.

- **Keywords:** FRAM; Infusion; Critical care

David Huegeli, Sarah Merks, Adrian Schwaninger. [*Automation reliability, human-machine system performance, and operator compliance: A study with airport security screeners supported by automated explosives detection systems for cabin baggage screening.*](#)

Using a simulated X-ray screening task, we tested 122 airport security screeners working with the support of explosives detection systems for cabin baggage screening (EDSCB) as low-level automation. EDSCB varied systematically on three automation reliability measures: accuracy, d', and positive predictive value (PPV). Results showed that when unaided performance was high, operator confidence was high, and automation provided only small benefits. When unaided performance was lower, operator confidence was lower, and automation with higher d' provided large benefits. Operator compliance depended on the PPV of automation: We found lower compliance for lower PPV. Automation with a high false alarm rate of 20% and a low PPV of .3 resulted in operators ignoring about one-half of the true automation alarms on difficult targets—a strong cry-

wolf effect. Our results suggest that automation reliability described by d' and PPV is more valid than using accuracy alone. When the PPV is below .5, operators should receive clear instructions on how to respond to automation alarms.

- **Keywords:** Human-automation interaction; Airport security baggage screening; Visual search

L. Claudon, K. Desbrosses, M.A. Gilles, A. Pichené-Houard, O. Remy, P. Wild. *Temporal leeway: can it help to reduce biomechanical load for older workers performing repetitive light assembly tasks?*

Current industrial production systems allow assembly of customised products which include additional elements distinguishing them from a reference model. This customisation can result in significant additional time constraints which compel workers to complete their tasks faster, which may pose problems for older workers. The objective of this laboratory study was to investigate the impact of restrictive or flexible pacing during assembly of customised products among groups of younger and older participants. The data gathered were used to analyse cycle-time, assembly performance, muscular load, and kinematic adaptations. The flexible pacing condition was found to improve production performance, increasing customised assembly cycle-time and reducing biomechanical load, for both young and older participants. However, as the task required fine manual dexterity, older participants were subjected to a higher biomechanical load, even in the flexible pacing scenario. These results should encourage assembly-line designers to allow flexible time constraints as much as possible and to be particularly attentive to the needs of older workers.

- **Keywords:** Ageing; Repetitive assembly work; Musculoskeletal disorders

Georgia J. Hay, Florian E. Klonek, Sharon K. Parker. *Diagnosing rare diseases: A sociotechnical approach to the design of complex work systems.*

How do complex healthcare systems that are organised into distinct speciality areas achieve effective patient care transitions when patients present with a rare constellation of symptoms that affect multiple body systems? How do these patients challenge existing ways of organising tasks, clinical activities, and interdependent responsibilities? The current study applies a sociotechnical systems perspective to understand how these complex work design and care-related challenges were resolved by the Western Australian Undiagnosed Diseases Program. We conducted a two-year longitudinal, qualitative study of this program, conceived to improve the diagnosis and management of patients with rare, multi-system disorders by piloting a re-design of the local system of diagnostic work. Specifically, we (1) compared the configuration and effectiveness of the old system and the re-designed system; and (2) analysed the process of system re-design (i.e., the design, implementation, and operation of the program) in order to understand the factors that contributed to – or inhibited – its success. We discuss the theoretical and practical implications of our findings for effectively re-designing complex, trans-organisational work systems.

- **Keywords:** Sociotechnical systems; Work design; Work re-design; Healthcare

Tjaša Kermavnar, Kevin J. O'Sullivan, Vincent Casey, Adam de Eyto, Leonard W. O'Sullivan. *Circumferential tissue compression at the lower limb during walking, and its effect on discomfort, pain and tissue oxygenation: Application to soft exoskeleton design.*

Soft exoskeletons apply compressive forces at the limbs via connection cuffs to actuate movement or stabilise joints. To avoid excessive mechanical loading, the interface with the wearer's body needs to be carefully designed. The purpose of this study was to establish the magnitude of circumferential compression at the lower limb during walking that causes discomfort/pain. It was hypothesized that the thresholds differ from those during standing. A cohort of 21 healthy participants were tested using two sizes of pneumatic cuffs, inflated at the thigh and calf in a tonic or phasic manner. The results showed lower inflation pressures triggering discomfort/pain at the thigh, with tonic compression, and wider pneumatic cuffs. The thresholds were lower during walking than standing still. Deep tissue oxygenation increased during phasic compression and decreased during tonic compression. According to the findings, circumferential compression by soft exoskeletons is preferably applied at anatomical sites with smaller volumes of soft tissue, using narrow connection cuffs and inflation pressures below 14 kPa.

- **Keywords:** Soft exoskeleton-human interaction; Mechanical soft tissue loading; Walking

Dominik Krumm, Stefan Schwanitz, Stephan Odenwald. *Seat cushions made of warp knitted spacer fabrics influence seat transmissibility.*

The aim of this study was to compare the application of different warp knitted spacer fabrics on a car seat shell to a standard seat in terms of vertical seat transmissibility. Furthermore, the results obtained by human subject tests were compared to results of an anthropodynamic dummy test. Experiments were conducted on a vertically actuated platform under laboratory conditions with 16 human subjects and an anthropodynamic dummy. Seat Effective Amplitude Transmissibility of the seat pan and the seat backrest were calculated to evaluate ride quality. Seat transmissibility ranged between 73.6% for backrest and 177.7% for pan. Based on the results of statistical tests, the hypothesis that the transmissibility of a seat would be influenced by seat cushion conditions was accepted ($p < 0.05$). It was also shown that an anthropodynamic dummy test could replace tests with human subjects ($r^2 = 0.907$) if the target population was matched sufficiently.

- **Keywords:** Anthropodynamic dummy; Vibration; Automotive

Kristian Ringsby Odberg, Britt Sætre Hansen, Karina Aase, Sigrid Wangensteen. *A work system analysis of the medication administration process in a Norwegian nursing home ward.*

Nursing home patients often have multiple diagnoses and a high prevalence of polypharmacy and are at risk of experiencing adverse drug events. The study aims to explore the dynamic interactions of stakeholders and work system elements in the medication administration process in a nursing home ward. Data were collected using observations and interviews. A deductive content analysis led to a SEIPS-based process map and an accompanying work system analysis. The study increases knowledge of the complexity of the medication administration process by portraying the dynamic interactions between the major stakeholders in the work system, and the temporal flow of the activities involved. Secondly, it identifies facilitators and barriers in the work system linked to the medication administration process. Most barriers and facilitators are associated with the work system elements – tools & technology, organisation and tasks – and occur early in the medication administration process.

- **Keywords:** Medication administration; Patient safety; Human factors; Nursing homes

Ka-Po Maggie Tang, Yuen-Shing Wu, Jin-tu Fan. *Effect of material property, surface temperature and contact duration on the thermal sensation when contacting shell materials of electronic devices.*

Heat generated in electronic devices is generally unevenly distributed across the casing. Contacting the hot areas may cause thermal discomfort and possibly skin burn. This study aims at better understanding the interrelationship between the thermal sensation, material properties and surface temperature for enhancing the user experience of electronic devices. A Thermal Simulation System was developed in this study to precisely control the surface temperature of shell materials to simulate various end-use conditions. Seventeen participants were asked to contact the plates with their fingers and rate their thermal sensation using the magnitude estimation approach. Results showed that thermal sensation magnitude and plate temperature followed a power function. The differences in sensation magnitude can be attributed to the thermal inertias of different materials. The findings suggested that laminated plate was generally perceived cooler when heated. Given that the surface temperature of plate is higher than skin, the thermal sensation magnitude increases with contact duration.

- **Keywords:** Thermal sensation; Material selection; Subjective assessment

Maximilian J. Stanglmeier, Florian K. Paternoster, Susanne Paternoster, Raphael J. Bichler, Peer-Oliver Wagner, Ansgar Schwirtz. *Automated driving: A biomechanical approach for sleeping positions.*

Occupants of autonomous vehicle have frequently indicated the desire to sleep or rest while driving, yet little has been known regarding the suitable design criteria for a biomechanically reasoned in-vehicle sleeping position. This study was aimed at evaluating the biomechanical quality of different backrest and seat pan angle combinations, and at predicting the most favourable sleeping positions based on vehicle restriction. More specifically, the interface pressure distribution and subjective suitability rating of 23 subjects was assessed in a total of nine (3 × 3) combinations of seat pan (20°, 30°, 40°) and backrest (145°, 155°, 165°) angles. Biomechanical quality was evaluated with an interface pressure score (IPS) based on sensitivity weighted pressures and the total contact area. Two-way repeated measures ANOVA revealed that IPS significantly improves with increasing seat pan angle whereas backrest angles of 155° or 165° lead to significant better IPS compared to flatter ones (145°). The overall highest IPS was observed for a 40°-seat pan angle in combination with a 155°-backrest angle. Subjective suitability rating revealed that people prefer a combination of 165° backrest angle with a seat pan of 20°; however, eight of nine combinations can be considered as suitable for sleeping. Therefore, the combination of a 40°-seat pan angle and 155° backrest is recommended by the present study for an in-vehicle sleeping position due to the increased biomechanical quality.

- **Keywords:** Autonomous driving; Automated driving; Sleeping posture; Seating; Seat design; Posture variation; Posture analysis; Interface pressure; Transportation; Biomechanics; Ergonomics

Teresa Zayas-Cabán, P. Jon White. *The national health information technology human factors and ergonomics agenda.*

Health information technology (IT) implementation has encompassed much of the United States health care system over the past decade, and user frustration with health IT has steadily increased. Human factors and ergonomics (HFE) methods and approaches can improve the design, implementation, and use of health IT for clinicians and consumers. To better understand the effect of federal HFE in health IT research funding, the authors conducted a review of several key, specific initiatives. The review focused on the goals

and accomplishments of these initiatives. Findings to date show that HFE is improving the usefulness of health IT, but additional research and new methods are needed. Corresponding research funding and policy priorities are identified. New HFE work and innovative approaches are needed to capitalize on HFE knowledge, principles, and methods to improve the design, implementation, and use of health IT at a broader scale.

- **Keywords:** Human factors and ergonomics; Health care; Health information technology

Jennifer A. Hess, Laurel Kincl, Douglas L. Weeks, Amelia Vaughan, Dan Anton. *Safety Voice for Ergonomics (SAVE): Evaluation of a masonry apprenticeship training program.*

Background: Masons have a high rate of musculoskeletal disorders among construction workers and greater than all other industries. Viable solutions to musculoskeletal hazards have been identified by industry stakeholders, yet masons receive minimal ergonomics training. Apprentices, as the next generation of masons, need training and strategies to identify and speak up about ergonomic and safety issues on job sites. To fill this gap, our team developed the Safety Voice for Ergonomics (SAVE) training program. **Methods:** The interactive, 7-unit SAVE program was developed specifically for masonry brick and block apprentices. This innovative training contains detailed ergonomics lessons focusing on risk factors and solutions specific to this masonry craft. It also contains lessons that provide communication and problem solving strategies. Evaluation of SAVE employed a randomized control trial designed to assess the effectiveness of SAVE for apprentices over a six-month period. **Results:** Our findings demonstrated that compared to controls, SAVE trained apprentices used their safety voice more ($P = .049$) and had greater safety participation ($P = .028$). They adopted more ergonomic practices such as adjusting scaffolding ($P = .016$) and using better body postures ($P = .042$). Apprentices liked SAVE and indicated that it prompted them to change workplace safety behaviors. **Conclusions:** SAVE is an effective program, providing needed ergonomic and safety communication training for workers as they begin their trade. The broad adoption of SAVE training by the masonry industry has the potential to empower apprentices, elevate the trade's safety culture, and ultimately reduce musculoskeletal disorders.

- **Keywords:** Construction; Soft tissue injuries; Safety communication; Health & safety

Patrick Lawson, Carl J. Pearson, Aaron Crowson, Christopher B. Mayhorn. *Email phishing and signal detection: How persuasion principles and personality influence response patterns and accuracy.*

Phishing is a social engineering tactic where a malicious actor impersonates a trustworthy third party with the intention of tricking the user into divulging sensitive information. Previous social engineering research in a real-world setting has shown an interaction between the personality of the target and the persuasion principle used. This study investigated whether this interaction is present in the realm of email phishing. Additionally, a signal detection theory framework was used to evaluate how the various persuasion principles influence accuracy, sensitivity (d'), and response criterion placement. A personality inventory and an email identification task (phishing or legitimate) were used. These data support previous findings that high extroversion is predictive of increased susceptibility to phishing attacks. The various persuasions principles elicited diverse response criteria and sensitivities, though all investigated persuasion principles resulted in a liberal decision criterion, except one. These findings are interpreted and discussed.

- **Keywords:** Phishing; Cybersecurity; Susceptibility; Signal detection; Persuasion principle; Personality

Žiga Kozinc, Saskia Baltrusch, Han Houdijk, Nejc Šarabon. *Reliability of a battery of tests for functional evaluation of trunk exoskeletons.*

Recently, several spinal exoskeletons were developed with the aim to assist occupational tasks such as load-handling and work in prolonged static postures. While the biomechanical effects of such devices has been well investigated, only limited feedback to the developers is usually provided regarding the subjective perceptions of the end-users. The aim of this study was to present a novel battery of tests, designed to assess functional performance and subjective outcomes during the use of assistive trunk exoskeletons, and to assess its test-retest reliability. The battery of tests consists of 12 different simple functional tasks. Twenty participants were included in an intra-session reliability test and repeated the tests within 7–10 days to assess inter-session reliability. They were wearing a novel passive spinal exoskeleton during all trials. The outcomes included quantitative and subjective measures, such as performance time and rating of discomfort and perceived task difficulty. The majority of the outcome measures were reliable within session and between sessions (ICC or $\alpha > 0.80$). Systematic effects were observed in a few tasks, suggesting that familiarization trials will be needed to minimize the learning effects. The novel battery of tests could become an important easy-to-use tool for functional testing of the spinal exoskeletons in addition to more specific biomechanical and physiological testing. Further studies should address the reliability of the present battery of tests for assessing specific populations, such as low back pain patients and explore how to minimize systematic effects that were observed in this study.

- **Keywords:** Robotics; Assistive device; Functional test; Trunk; Low back pain

Elisa F.D. Canetti, Ben Schram, Robin M. Orr, Joseph Knapik, Rodney Pope. [*Risk factors for development of lower limb osteoarthritis in physically demanding occupations: A systematic review and meta-analysis.*](#)

This systematic review and meta-analysis identified and critically reviewed the findings of recent studies (last 15 years) examining relationships between specific physically demanding occupations or occupational tasks and development of lower limb osteoarthritis (OA). Twenty-eight studies with 266,227 cases of lower limb OA were included. Occupational tasks contributing to OA included farming, floor laying, and brick laying. Activities significantly contributing to the risk of knee OA were lifting heavy loads (>10 kg/week) (odds ratio [OR] = 1.52, 95% confidence interval [95%CI] 1.29–1.79), squatting/kneeling (OR = 1.69, 95%CI 1.15–2.49), standing (>2 h/daily) (OR = 1.22 95%CI 1.02–1.46) and walking (OR = 1.40 95%CI 1.14–1.73). Lifting contributed significantly to the risk of hip OA (OR = 1.35, 95%CI 1.16–1.57). The effects of occupational exposures appear to be magnified by previous injury and BMI >25 kg/m². Since specific occupational activities increase OA risk, ergonomist should encourage the use of existing tools, or oversee the design of new tools that may decrease exposure to such activities.

- **Keywords:** Risk factors; Lower limb; Osteoarthritis; Occupations; Occupational task

Shuling Li, Tingru Zhang, Wei Zhang, Na Liu, Gaoyan Lyu. *Effects of speech-based intervention with positive comments on reduction of driver's anger state and perceived workload, and improvement of driving performance.*

Research suggests that speech-based interventions can mitigate driving anger and enhance road safety. The present study found that both positive and negative comments

can reduce anger state and perceived workload, and improve driving performance. In addition, positive comment including description of the driving environment and comment on drivers is more effective than negative comment intervention, which is indicated by larger effect size and higher user satisfaction and acceptance. The research findings could provide practical implications on the design of in-vehicle intelligent agents for driving behavior intervention.

- **Keywords:** Driving anger; Speech-based intervention; Positive comments