

## **Ergonomics– rok 2023, ročník 66**

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**Giovanna Ottaviani Aalmo, Raffaele Spinelli, Natascia Magagnotti & Rien Visser. *Quantitative and qualitative workload assessment in steep terrain forest operations: fostering a safer work environment through yarder automation*. Pages: 717-729.**

Many forestry roles have changed from being manual tasks with a high physical workload to being a machine operator task with a high mental workload. Automation can support a decrease in mental fatigue by removing tasks that are repetitive and monotonous for the operators. Cable yarding presents an ideal opportunity for early adoption of automation technology; specifically the carriage movement along a defined corridor. A Valentini V-850 cable yarder was used in an Italian harvesting setting, in order to gauge the ergonomic benefit of carriage control automation. The study showed that automating yarder carriage movements improved the ergonomic situation of the workers directly involved in the related primary tasks. However, the caveat is that improving one work task may negatively affect the other work tasks, and therefore introducing automation to a worksite must be done after considering all impacts on the whole system. **Practitioner summary:** Automation decreased the winch operator's mental workload while improving overall productivity. At the same time, the mental and physiological workload of the operator tasked with bucking were slightly increased. Ideally, winch automation should be coupled with bucking mechanisation to balance the intervention and boost both operator well-being and productivity.

- **Keywords:** HRV, task, logging, NASA TLX

**Bhawana Rathore, Baidyanath Biswas, Rohit Gupta & Indranil Biswas. *A retrospective analysis of the evolution of ergonomics for environmental sustainability (2011–2021)*. Pages: 730-748**

*Ergonomics for environmental sustainability* has been rapidly gaining attention in the scientific community. So far, a large part of the literature has focussed on specific dimensions of *ergonomics for environmental sustainability*, such as green designs, green buildings, environmental education, and sustainability frameworks. However, there is a necessity for an integrated study that presents the summary of published literature supported by detailed bibliometric characteristics. To address this gap, this study

examined 418 articles on *ergonomics for environmental sustainability* and analysed them through bibliometric and network analysis. Major findings reveal the publication trends in *ergonomics for environmental sustainability* starting from 2011 to the present, the most productive and influential authors, and the most influential articles. This study also identifies the co-citation structure, bibliographical couplings and keyword co-occurrences among these articles. Findings from this study also provide a summary of the current research and present a robust roadmap for future directions in *ergonomics for environmental sustainability*. **Practitioner summary:** This paper presents a bibliometric and network analysis of the academic literature in the domain of *ergonomics for environmental sustainability*. The study provides comprehensive insights into the relevant literature and identifies global research foci and future scopes. This study can guide practitioners in identifying the specific aspects of *ergonomics for environmental sustainability* to reduce global environmental impacts.

- **Keywords:** Ergonomics for environmental sustainability, Sustainability, Bibliometric analysis, Network analysis, Co-occurrence networks

**Nathalie M. C. W. Oomen, Ryan B. Graham & Steven L. Fischer. *Exploring the role of task on kinematic variability and assessing consistency in individual responses across repetitive manual tasks*. Pages: 749-761.**

To gain a greater understanding of motor variability (MV) as an individual trait, the effect of task type on MV and individual consistency in MV across three tasks was investigated. Twenty participants performed repetitive carrying, lifting, and simulated sawing tasks. MV was assessed using the linear measure of mean point-by-point standard deviation in three-dimensional upper body joint angles. Task type affected MV, where carrying showed higher MV compared to sawing (23–29%) and lifting (12–19%). Furthermore, MV was higher in lifting compared to sawing (12–25%). Poor to moderate individual consistency (ICC = 0.42–0.63) was found across tasks. Task type determined MV and only some support for MV as an individual trait across tasks was found. Based on this work, differences in degrees of freedom afforded by the task influence the opportunity to exploit MV, and possibly individual consistency in MV magnitude is specific to the degrees of freedom afforded by the task. **Practitioner summary:** In repetitive tasks, movement variability has been proposed as an individual characteristic independent of task characteristics, where repeaters show consistently low variability, while replacers show consistently high variability. In the current study, only moderate support was demonstrated for variability as a consistent individual characteristic across different manual tasks.

- **Keywords:** Repetitive tasks, manual tasks, motor variability, kinematic variability, individual consistency

**Richard Clewley & Jim Nixon. *A new facet of category theory: cognitive disadvantage and its implications for safety in the cockpit*. Pages: 762-77.**

The typicality effect suggests typical category members provide a cognitive advantage, such as being quicker and easier to recognise and describe. The reverse effect has not been explored in an applied environment. Non-typical flight safety events appear to pose problems for pilots, leading to delayed recognition and ineffective use of checklists. Fifty-six airline pilots completed an experiment that tested a real-world typicality gradient, comparing pilot performance on a group of four non-typical events against four randomly selected events. Non-typical flight safety events elicited a greater number of response errors and a greater response latency when compared with a random selection of safety events. We specify and measure cognitive disadvantage and suggest innovations in pilot education, such as locating troublesome events and improving recognition guidance. Our new findings can be used to better prepare pilots for event diversity and inform safety in

other work systems of interest to ergonomics. **Practitioner summary:** Typical safety events in work environments provide a cognitive dividend, supporting effective recognition and response. In this study, we frame and measure the opposite effect, the cognitive disadvantages of non-typical events. Non-typical events pose significant risk in work systems such as air transport, and we suggest innovations in pilot knowledge and training that make use of this approach.

- **Keywords:** Cognitive disadvantage, categories, typicality effect, flight safety events, pilot response

**Kirsty M. Lynch, Victoria A. Banks, Aaron P.J. Roberts, Stewart Radcliffe & Katherine L. Plant. *Maritime autonomous surface ships: can we learn from unmanned aerial vehicle incidents using the perceptual cycle model?* Pages: 772-790.**

Interest in Maritime Autonomous Surface Ships (MASS) is increasing as it is predicted that they can bring improved safety, performance and operational capabilities. However, their introduction is associated with a number of enduring Human Factors challenges (e.g. difficulties monitoring automated systems) for human operators, with their 'remoteness' in shore-side control centres exacerbating issues. This paper aims to investigate underlying decision-making processes of operators of uncrewed vehicles using the theoretical foundation of the Perceptual Cycle Model (PCM). A case study of an Unmanned Aerial Vehicle (UAV) accident has been chosen as it bears similarities to the operation of MASS through means of a ground-based control centre. Two PCMs were developed; one to demonstrate what *actually* happened and one to demonstrate what *should* have happened. Comparing the models demonstrates the importance of operator situational awareness, clearly defined operator roles, training and interface design in making decisions when operating from remote control centres. **Practitioner Summary:** To investigate underlying decision-making processes of operators of uncrewed vehicles using the Perceptual Cycle Model, by using an UAV accident case study. The findings showed the importance of operator situational awareness, clearly defined operator roles, training and interface design in making decisions when monitoring uncrewed systems from remote control centres.

- **Keywords:** Decision making, maritime autonomous surface ships, perceptual cycle model, unmanned aerial vehicle, UAV

**Brahim Benaissa & Masakazu Kobayashi. *The consumers' response to product design: a narrative review.* Pages: 791-820.**

This paper reviews the research ideas around consumer response to product design. From the product side, we discuss the most significant design features preferred by average consumers, such as aesthetics and utility. And from the consumer side, we investigate the human factors influencing consumer perceptions. We present the main approaches used to measure the consumer response to product design and summarize the multiple biases that occur during the evaluation. Finally, we present in detail the most commonly used methods to analyze consumer response data and their roles in the design evaluation context. **Practitioner Summary:** To answer the question: What causes differences in design response? We summarise the research findings related to product design features and human factors. We highlight the biases that can emerge from the measurement approach. And discuss the most common analysis methods used for product design response information.

- **Keywords:** Product design, consumer design perception, product design response

**Flávia Xavier Macedo de Azevedo, Rüdiger Heimgärtner & Karsten Nebe. *Development of a metric to evaluate the ergonomic principles of assistive systems, based on the DIN 92419. Pages: 821-848.***

The DIN 92419 defines six principles for assistive systems' ergonomic design. There is, however, a lack of measurement tools to evaluate assistive systems considering these principles. Consequently, this study developed a measurement tool for the quantitative evaluation of the fulfilment of each principle for assistive systems. A systematic literature review was performed to identify dimensions belonging to the principles, identify how previous research evaluated these dimensions, and develop a measurement tool for assistive systems. Findings show that scales commonly used for evaluating assistive systems disregard several aspects highlighted as relevant by research, implying the need for considering the DIN 92419 principles. Based on established scales and theoretical findings, a questionnaire, and a checklist for evaluating assistive systems were developed. The work provides a grounding for measuring relevant aspects of assistive systems. Further development is needed to substantiate the reliability and validity of the proposed questionnaire scales and items. **Practitioner Summary:** Responding to the gap of a holistic measurement tool to evaluate assistive systems, a systematic literature review was performed considering the DIN 92419 principles. This resulted in a comprehensive summary of relevant aspects of assistive systems that were made numerically measurable, which proposes better criteria to assess assistive systems.

- **Keywords:** Assistive systems, evaluation, measurement, ergonomics, design

**Andre M. Dempsey, Andrew K. Yegian, Benjamin E. Sibson & Daniel E. Lieberman. *The effect of vertical load placement on metabolic rate during loaded walking in humans. Pages: 849-858.***

We examined the effects of vertical load placement on the metabolic cost of walking. Twelve healthy participants walked on a treadmill with 13.8 and 23.4 kg loads in both high and low vertical positions. Metabolic rate was measured using respirometry. While load position had no effect on the net metabolic rate for the 13.8 kg load, the net metabolic rate with the 23.4 kg load was significantly reduced by 4.3% in the high vertical load position compared to the low vertical load position. Loads carried higher on the trunk were also associated with increased forward trunk lean that reduced the load gravitational moment arm in the sagittal plane suggesting that reduction of fore-aft upper body torques is an energy-saving mechanism during loaded walking. **Practitioner Summary:** Load placement within a backpack affects the biomechanics of load carriage. We experimentally tested the metabolic cost of high and low load placement during walking and found the high position to be less costly with large loads. Loading high may be the optimal technique for carrying heavy backpacks.

- **Keywords:** Biomechanics, loading, metabolic rate, walking

**Pauline Maurice, Félix Cuny-Enault & Serena Ivaldi. *Influence of a passive back support exoskeleton on simulated patient bed bathing: results of an exploratory study. Pages: 859-873.***

Low-back pain is a major concern among healthcare workers. One cause is the frequent adoption of repetitive forward bent postures in their daily activities. Occupational exoskeletons have the potential to assist workers in such situations. However, their efficacy is largely task-dependent, and their biomechanical benefit in the healthcare sector has rarely been evaluated. The present study investigates the effects of a passive back support exoskeleton in a simulated patient bed bathing task. Nine participants performed the task on a medical manikin, with and without the exoskeleton. Results show that working with the exoskeleton induced a significantly larger trunk forward

flexion, by 13 deg in average. Due to this postural change, using the exoskeleton did not affect substantially the muscular and cardiovascular demands nor the perceived effort. These results illustrate that postural changes induced by exoskeleton use, whether voluntary or not, should be considered carefully since they may cancel out biomechanical benefits expected from the assistance. **Practitioner summary:** Low-back pain is a major concern among nurses, associated with bent postures. We observed that using a passive back-support exoskeleton during the typical patient bed bathing activity results in a larger trunk flexion, without changing muscular, cardiovascular or perceived physical effort.

- **Keywords:** Passive exoskeletons, healthcare ergonomic, slow back demand, electromyography