

## Ergonomics– rok 2022, ročník 65

### Číslo 3



**Abigail R. Wooldridge, Widya A. Ramadhani, Keith Hanson, Elsa Vazquez-Melendez, Harleena Kendhari, Nadia Shaikh, Teresa Riech, Matthew Mischler, Sara Krzyzaniak, Ginger Barton, Kyle T. Formella, Zachary R. Abbott, John N. Farmer, Rebecca Ebert-Allen & Trina Croland. *Walking the line: balancing performance barriers and facilitators in an augmented reality mobile application for paediatric code cart training.* Pages: 334-347.**

An augmented reality (AR) mobile smartphone application was developed for clinicians to improve their knowledge about the contents and organisation of a standardised paediatric code cart, an important tool in safe, effective paediatric resuscitations. This study used focus groups and interviews with 22 clinicians to identify work system barriers and facilitators to use of the application. We identified twelve dimensions of barriers and facilitators: convenience, device ownership, device size and type, gamification, interface design, movement/physical space, perception of others, spatial presence, technological experience, technological glitches, workload, and the perception and attitude towards code cart and resuscitation. These dimensions can guide improvement efforts, e.g. redesigning the interface, providing non-AR modes, improving the tutorial. We propose nine principles to guide the design of other digital health technologies incorporating AR. In particular, the workload demands created by using AR must be considered and accounted for in the design and implementation of such technologies. **Practitioner summary:** Augmented reality (AR) may prepare workers for situations that do not occur frequently. This study investigates barriers and facilitators to using an AR mobile smartphone application developed to improve clinician knowledge about code carts, leading to improvements to the application and principles to guide the design of other AR-based technologies.

- **Keywords:** Augmented reality, paediatric resuscitation, code carts, sociotechnical system design, work system analysis

**Gemma J. M. Read, Katie Schultz, Natassia Goode & Paul M. Salmon. *Using cognitive work analysis to identify competencies for human factors and ergonomics practitioners.* Pages: 348-361.**

While several competency frameworks have been proposed for Human Factors and Ergonomics (HFE) practitioners, these are not commonly based on structured analyses. The aim of this research was to develop a sociotechnical systems model of the HFE practitioner role in Australia and identify the competencies required to fulfil the role. Study One applied the Work Domain Analysis phase of cognitive work analysis (CWA) to model the HFE practitioner role. Model refinement was undertaken with seven subject matter experts. In Study Two, the model was used to elicit the competencies (knowledge, skills, abilities, other characteristics) required for successful performance, via a survey of 28 HFE practitioners. Most competencies related to skills (i.e. communication skills) and knowledge (i.e. domain knowledge). Gaps in competencies were also identified, linked to a lack of HFE education pathways in Australia. The findings have practical utility for designing HFE practitioner roles and educational programs. **Practitioner summary:** Cognitive work analysis provided a structured analysis of the role of the Human Factors and Ergonomics (HFE) practitioner and to support the identification of competencies. The results suggest that HFE practitioners are generalists rather than specialists and have implications for the job design and education of HFE practitioners.

- **Keywords:** Cognitive work analysis, competencies, job design, practitioners, work domain analysis

**Irma Cecilia Landa-Avila, Carolina Escobar-Tello, Gyuchan Thomas Jun & Rebecca Cain. [Multiple outcome interactions in healthcare systems: a participatory outcome mapping approach](#). Pages: 362-383.**

Outcomes, which are the result state or condition from a process or intervention, are essential elements of healthcare system design and an important indicator of performance. They are included in well-known system analysis frameworks such as the Systems Engineering Initiative for Patient Safety (SEIPS) and Cognitive Work Analysis (CWA). However, fewer practical approaches exist for understanding and communicating interactions among healthcare outcomes. This study applies a novel mapping method as a practical approach to collect, aggregate and visualise interrelations among multiple healthcare outcomes. Graphic facilitation mapping sessions with eleven healthcare providers and ten patients with chronic conditions were conducted. Participants created outcome interrelationship maps following a six-step process. Two outcome-based network visualisations were synthesised using network analysis. This outcome-based approach advances how we frame healthcare systems, focussing on accommodating multiple stakeholders' visions, understanding interrelations, and defining trade-offs. This practical approach may complement frameworks such as SEIPS and CWA. **Practitioner summary:** The presented outcome-based mapping approach can facilitate the understanding of outcomes as part of the interrelated healthcare system. The approach allows the discussion and integration of different stakeholders' outcome priorities to identify critical elements and better inform the development or adaptation of healthcare systems.

- **Keywords:** Healthcare outcomes, systems thinking, participatory ergonomics, systems visualisations, wellbeing

**Neville A. Stanton, Aaron P. J. Roberts, Kiome A. Pope & Daniel Fay. [The quest for the ring: a case study of a new submarine control room configuration](#). Pages: 384-406.**

Submarine control room layouts have remained similar across decades of operation, despite the introduction of new technologies that allow for the co-location of the sound and control room. Operation of an inwards, rather than outwards, facing ring control room configuration was examined in three scenarios: Return to Periscope Depth, Inshore Operations, and Dived Tracking. A case study design employed a serving team of

qualified submariners participated in all three scenarios with high and low demand. Communications and activities in the control room were recorded and analysed using the Event Analysis of Systemic Teamwork (EAST) method. EAST models collaborative teamwork through social, information, and task networks. The results from the ring configuration were compared to an outward facing baseline of the contemporary control room layout with a separate sound and control room. The ring control room configuration increased communications between operators, leading to a more information exchanged, and more tasks completed. **Practitioner summary:** Control room design on submarines, and other domains, has traditionally been outward facing with supervisory staff looking over the shoulders of their subordinates. In this paper, an inward looking control room design was explored, with subordinate staff facing their supervisors. This design resulted in more information exchange and productive work.

- **Keywords:** Submarine, team, work, communications, networks, control room

**Adam Hulme, Neville A. Stanton, Guy H. Walker, Patrick Waterson & Paul M. Salmon. *Testing the reliability and validity of risk assessment methods in Human Factors and Ergonomics*. Pages: 407-428.**

There is growing interest in the use of systems-based risk assessment methods in Human Factors and Ergonomics (HFE). The purpose of this study was to test the intra-rater reliability and criterion-referenced concurrent validity of three systems-based risk assessment approaches: (i) the Systems-Theoretic Process Analysis (STPA) method; (ii) the Event Analysis of Systemic Teamwork Broken Links (EAST-BL) method; and, (iii) the Network Hazard Analysis and Risk Management System (Net-HARMS) method. Reliability and validity measures were obtained using the Signal Detection Theory (SDT) paradigm. Whilst STPA identified the highest number of risks, the findings indicate a weak to moderate level of reliability and validity for STPA, EAST-BL and Net-HARMS. There were no statistically significant differences between the methods across analyses. The results suggest that there is merit to the continued use of systems-based risk assessment methods following a series of methodological extensions that aim to enhance the reliability and validity of future applications. **Practitioner summary** The three risk assessment methods produced weak to moderate levels of stability and accuracy regarding their capability to predict risks. There is a pressing need to further test the reliability and validity of safety methods in Human Factors and Ergonomics.

- **Keywords:** Risk assessment, STPA, EAST-BL, Net-HARMS, reliability, validity

**Matt Staton, Jo Barnes, Andrew Morris & Patrick Waterson. 'Over to you': using a STAMP control structure analysis to probe deeper into the control of UK road safety at a municipal level – the case of Cambridgeshire. Pages: 429-444.**

The UK has seen little progress in reducing road death over the last decade and as a result, the government has been criticised by industry stakeholders for a lack of leadership, including the removal of national targets in 2011 and the devolution of powers to a municipal level. The aim of this paper is to understand how decision-making at a municipal level takes place from a systems perspective, using the case study of Cambridgeshire. Actors involved were mapped using a STAMP control structure analysis and highlighted a key role for formal and informal partnerships between local and national government agencies and non-government organisations at the same level in the control structure. The changing international context of the model for the UK is also discussed in relation to the UK's withdrawal from the European Union and provides a useful tool for future analysis of its effect on policy and decision-making. **Practitioner summary:** This paper uses a STAMP control structure analysis to understand how decision-making at a municipal level takes place from a systems perspective, using the

case study of Cambridgeshire. It highlights a key role for formal and informal partnerships between organisations at the same level in the control structure.

- **Keywords:** STAMP, road safety, systems theory, road safety management, Brexit

**Tiziana C. Callari, Michael Mortimer, Louise Moody, Mehdi Seyedmahmoudian, Ryan Lewis & Ben Horan. [Smooth and safe tram journeys: tram driver perspectives and opportunities using a haptic master controller in a virtual reality environment](#). Pages: 445-466.**

Tram drivers operate a master controller to control the acceleration and braking of the tram. Operation should ensure passenger comfort and safety through smooth tram motion and the avoidance of jerkiness that may cause passengers to fall in the carriage. This work investigates current driver practices and strategies for tram driving in normal operations through interviews and the capacity of a new haptic master controller to support drivers in achieving smooth and safe tram journeys. A haptic feedback algorithm based on viscosity was implemented on the master controller to provide drivers with feedback on the rate at which they were accelerating and braking the tram. This aspect was tested in a virtual tram within a simulated inner city virtual reality environment. Results indicate that the haptic master controller and coupled viscosity feedback algorithm did not increase smoothness of driving during the simulated experiences. Despite this, the drivers indicated a preference for the provision of further haptic information to support driving tasks and the overall journey safety and smoothness. **Practitioner Summary:** This research comprises two studies. The first investigates strategies currently used by drivers to operate a tram smoothly in order to elicit design requirements for a haptic tram master controller. The second study evaluates the impact of a novel haptic master controller on journey smoothness within a virtual environment.

- **Keywords:** Simulated tram environment, haptic technology, tram driver practices, tacit knowledge elicitation, 'Instruction to the Double' method

**E. Austin, B. Blakely, P. Salmon, J. Braithwaite & R. Clay-Williams. [The scope for adaptive capacity in emergency departments: modelling performance constraints using control task analysis and social organisational cooperation analysis](#). Pages: 467-484.**

Patient flow between the emergency department (ED) and hospital wards becomes problematic when bed availability is limited. To better understand the constraints that shape patient flow and everyday work in the ED, we applied Control Task Analysis (i.e. Contextual Activities Template, CAT) and Social Organisational Cooperation Analysis (SOCA) phases from the Cognitive Work Analysis framework to identify ways in which to optimise patient flow. The model and analysis were created through observations in the ED of clinicians (e.g. nurses, doctors), and professional staff (e.g. ward personnel, clerks). The CAT and SOCA-CAT models illustrate workspaces, patient journey phases, and patient volume within the department that are heavily loaded with tasks and human and non-human agents performing these tasks, while others are underutilised. The findings suggest that an ED's adaptive capacity could be strengthened through the integration of additional human and non-human agents allowing the redistribution of clinical and non-clinical tasks. **Practitioner Summary:** Workflow in EDs is constrained by uneven geographical distribution of activities, insufficient adaptive support during critical patient journey phases and periods of high patient volume. Adaptive capacity could be strengthened by additional human and non-human agents in combination with a redistribution of tasks, supporting seamless successful structural and behavioural adaptation in ED.

- **Keywords:** Allocation of functions, healthcare, Emergency Department, CWA, system design sociotechnical systems

**Ashleigh Brady & Neelam Naikar.** [\*Development of Rasmussen's risk management framework for analysing multi-level sociotechnical influences in the design of envisioned work systems.\*](#) **Pages: 485-518.**

Besides radically altering work, advances in automation and intelligent technologies have the potential to bring significant societal transformation. These transitional periods require an approach to analysis and design that goes beyond human-machine interaction in the workplace to consider the wider sociotechnical needs of envisioned work systems. The Sociotechnical Influences Space, an analytical tool motivated by Rasmussen's risk management model, promotes a holistic approach to the design of future systems, attending to societal needs and challenges, while still recognising the bottom-up push from emerging technologies. A study explores the concept and practical potential of the tool when applied to the analysis of a large-scale, 'real-world' problem, specifically the societal, governmental, regulatory, organisational, human, and technological factors of significance in mixed human-artificial agent workforces. Further research is needed to establish the feasibility of the tool in a range of application domains, the details of the method, and the value of the tool in design. **Practitioner summary:** Emerging automation and intelligent technologies are not only transforming workplaces, but may be harbingers of major societal change. A new analytical tool, the Sociotechnical Influences Space, is proposed to support organisations in taking a holistic approach to the incorporation of advanced technologies into workplaces and function allocation in mixed human-artificial agent teams.

- **Keywords:** Sociotechnical systems, AcciMap, human-automation interaction, function allocation, cognitive work analysis

**Mary Lavelle, Ara Darzi, Roksolana Starodub & Janet E. Anderson.** *The role of transactive memory systems, psychological safety and interpersonal conflict in hospital team performance.* **Pages: 519-529.**

Patient flow between the emergency department (ED) and hospital wards becomes problematic when bed availability is limited. To better understand the constraints that shape patient flow and everyday work in the ED, we applied Control Task Analysis (i.e. Contextual Activities Template, CAT) and Social Organisational Cooperation Analysis (SOCA) phases from the Cognitive Work Analysis framework to identify ways in which to optimise patient flow. The model and analysis were created through observations in the ED of clinicians (e.g. nurses, doctors), and professional staff (e.g. ward personnel, clerks). The CAT and SOCA-CAT models illustrate workspaces, patient journey phases, and patient volume within the department that are heavily loaded with tasks and human and non-human agents performing these tasks, while others are underutilised. The findings suggest that an ED's adaptive capacity could be strengthened through the integration of additional human and non-human agents allowing the redistribution of clinical and non-clinical tasks. **Practitioner Summary:** Workflow in EDs is constrained by uneven geographical distribution of activities, insufficient adaptive support during critical patient journey phases and periods of high patient volume. Adaptive capacity could be strengthened by additional human and non-human agents in combination with a redistribution of tasks, supporting seamless successful structural and behavioural adaptation in ED.

- **Keywords:** Allocation of functions healthcare Emergency Department CWA system design sociotechnical systems