Reimagining Rasmussen's risk management framework: a contemporary view on risk

Paul Salmon & Gemma Read

University of the Sunshine Coast, Australia

SUMMARY

Rasmussen's Risk Management Framework (RMF; Rasmussen, 1997) is arguably the most popular model of safety and risk within Ergonomics and Human Factors (EHF). However, the RMF was developed almost thirty years ago and there are questions regarding its suitability for contemporary systems and problems. In this presentation we outline and demonstrate a revised and extended RMF for contemporary sociotechnical systems.

KEYWORDS

Safety, Risk, Systems thinking

Introduction

Systems thinking is a core philosophy within Ergonomics and Human Factors (EHF) that is used to help understand and optimise performance and safety within complex sociotechnical systems. The philosophy is characterised by several models and methods which assert that safety and accidents are emergent properties arising from non-linear interactions between multiple components across work and societal systems (Leveson, 2004; Rasmussen, 1997). Rasmussen's risk management framework (RMF; Rasmussen, 1997) is arguably the most popular systems thinking model within EHF and safety science (Salmon et al., 2020) and along with the associated Accident Mapping (AcciMap) method has been used extensively over the past two decades. These applications have sought to understand and respond to complex problems in a diverse set of contexts ranging from the traditional EHF domains of defence, process control, healthcare, and transport to emerging application areas such as elite sport, outdoor recreation, and food safety (Salmon et al., 2020). Though the RMF's core propositions have been validated in these areas, flaws are evident, and the changing nature of work, technologies, societal issues, and global risks is beginning to expose gaps.

The aim of this paper is to return once again to the question posed in Rasmussen's seminal paper: *do we actually have adequate models of accident causation in the present dynamic society?* While the RMF has high utility and has provided important insights about safety and accident causation, given the changing context we argue that the answer is no. Therefore, we propose a revised and extended version of the RMF that is more suited to contemporary systems and problems. The revised RMF will be outlined in the conference presentation and demonstrated via a contemporary case study focused on the use of artificial intelligence in the higher education sector.

The revised risk management framework

Our work applying the RMF, Accimap, and associated models such as the Systems Theoretic Accident Model and Processes (STAMP; Leveson, 2004) in close to 20 domains has revealed important limitations. First, the current representation of complex systems as a hierarchy is artificial and overlooks dynamic interactions between actors that bypass 'system levels'. The focus on work at the bottom of the hierarchy also overlooks the fact that work occurs throughout the entire system. Second, though Rasmussen (1997) acknowledged the rapid pace of technological change, the RMF does not account for increasingly advanced non-human actors such as artificial intelligence technologies. This issue is compounded by rapid progress in the area and the likely future development of artificial general intelligence technologies that could surpass human levels of intelligence (Salmon et al., 2023). Third, central concepts of vertical integration and migration remain high level and have not been further developed, validated, or expanded, despite their critical role in system functioning. For example, how such concepts are influenced by contemporary societal issues such as misinformation, social media, artificial intelligence, pandemics, geopolitical tensions, and geostrategic shifts requires clarification.

Based on our extensive applications of the RMF, AcciMap, and STAMP, and the limitations described above, we propose a dynamic network-based RMF. This includes the following key features:

1. **Complex systems as a network**. Rather than viewing complex systems as a hierarchy, we instead propose that they comprise a dynamic network of actors and activities that are connected via control and feedback mechanisms. The number, relative power, and connectedness of actors differs across domains and is dynamic and changeable across situations.
2. **Human and non-human actors**. Complex systems comprise both human and non-human actors, with the latter becoming increasingly intelligent, autonomous, and influential. Rather than existing only on the frontline, intelligent non-human actors such as artificial intelligence are present throughout the system network and are increasingly enacting controls and providing feedback associated with supervisory, managerial and regulatory functions.
3. **Societal influences and pressures on behaviour**. An expanding range of interacting societal issues are having an increasing influence on behaviour within complex systems. Examples issues include the COVID-19 pandemic, economic and cost-of-living crises, societal health, misinformation, and current geostrategic shifts.

Discussion

Rasmussen's seminal RMF has had a significant influence on the discipline of EHF and continues to shape system safety research and practice in a diverse set of domains. In this presentation, we contend that refinement is required to support its continued use and relevance.

References

Leveson, N. (2004). A new accident model for engineering safer systems. *Safety science*, *42*(4), 237-270.

Rasmussen, J. (1997). Risk management in a dynamic society: a modelling problem. *Safety science*, *27*(2-3), 183-213.

Salmon, P. M., Hulme, A., Walker, G. H., Waterson, P., Berber, E., & Stanton, N. A. (2020). The big picture on accident causation: A review, synthesis and meta-analysis of AcciMap studies. *Safety science*, *126*, 104650.

Salmon, P. M., Baber, C., Burns, C., Carden, T., Cooke, N., Cummings, M., ... & Stanton, N. A. (2023). Managing the risks of artificial general intelligence: A human factors and ergonomics perspective. *Human Factors and Ergonomics in Manufacturing & Service Industries*, *33*(5), 366-378.