Human Factors Guidance for Robotic and Autonomous Systems (RAS)

Claire Hillyer[1], Hannah State-Davey[1], Nicole Hooker[1], Richard Farry[1], Russell Bond[2], James Campbell[2], Phillip Morgan[3], Dylan Jones[3], Juan D. Hernández Vega[3] & Philip Butler[3]

[1]QinetiQ, UK, [2]BMT, UK, [3]Cardiff University, UK

SUMMARY

This paper outlines recent (2021/2022) work to produce Human Factors (HF) guidance to support the design, development, evaluation, and acquisition of Robotic and Autonomous Systems.

KEYWORDS

Robotic, autonomous, system, human factors, human-centred design, artificial intelligence, system

Background and Context

Robotic and Autonomous Systems (RAS)[1] will play an increasingly important role in Defence Capability and they are likely to have a fundamental impact on the way in which future military activities, across the spectrum, are conducted (e.g. combat, humanitarian relief, cyber operations and operational support functions). This will have consequences on, for example: how people interact with these systems; the skills required to acquire, operate and maintain them; and the number, organisation, and location of these personnel. Understanding how to optimise both the human and technological components of such systems is critical.

While significant systematic research has been conducted into RAS technologies, relatively little *human science* research has been conducted outside of generic work on Human-Computer Interaction (HCI) or on topics such as the safety of Remotely Piloted Vehicles (RPVs). There is still a lot to learn about how humans might interact with complex RAS and how these technologies might be, optimally, integrated with the human component, both at the individual and at the collective level (such as might be reflected in Human-Machine Teaming, HMT[2]).

Development of RAS is progressing at pace and timely guidance, covering the Human Factors (HF) considerations associated with these systems, is essential to support Defence to design, field and operate RAS and build appropriate trust in these systems.

Exploration Guide – 'Human Factors Considerations for the Development and Testing of Robotic and Autonomous Systems'

In 2021/2022, a study was conducted to produce an Exploration Guide to raise awareness of the HF opportunities and challenges associated with the use of RAS by Defence and to provide advice and guidance on how to respond to these. Key considerations include: Situational Awareness (SA) and

[1] RAS is an accepted term used by academia and the science and technology community to highlight the physical (robotic) and/or cognitive (autonomous) aspects of a system (or platform).

[2] HMT is, essentially, a relationship – one made up of at least three equally important elements: the human, the machine and the interactions and interdependencies between them.

workload; system trust and reliability; decision transparency and explainability (i.e. what is the logic, process, factors or reasoning upon which an Artificial Intelligence (AI)-enabled system's actions or recommendations are based); physical design considerations; and HMT and communication. It draws on the outputs of a comprehensive review of over 300 publications including empirical research, published best practice, and standards and guidelines examining the design and operation of systems (within both military and non-military domains). Initially, a set of 60 search terms was developed and 1014 papers identified for review (via Google Scholar). The team conducted a relevance scoring activity to filter the papers down to a core set of 272 papers and this set was supplemented with additional information sources (including the Defence Standard (Def Stan) 00-251 'Human Factors Integration for Defence Systems' Technical Guides). The final set of papers was subject to a more detailed review and key themes were identified, for inclusion in the final Guide.

Figure 1 shows example excerpts from the Exploration Guide.

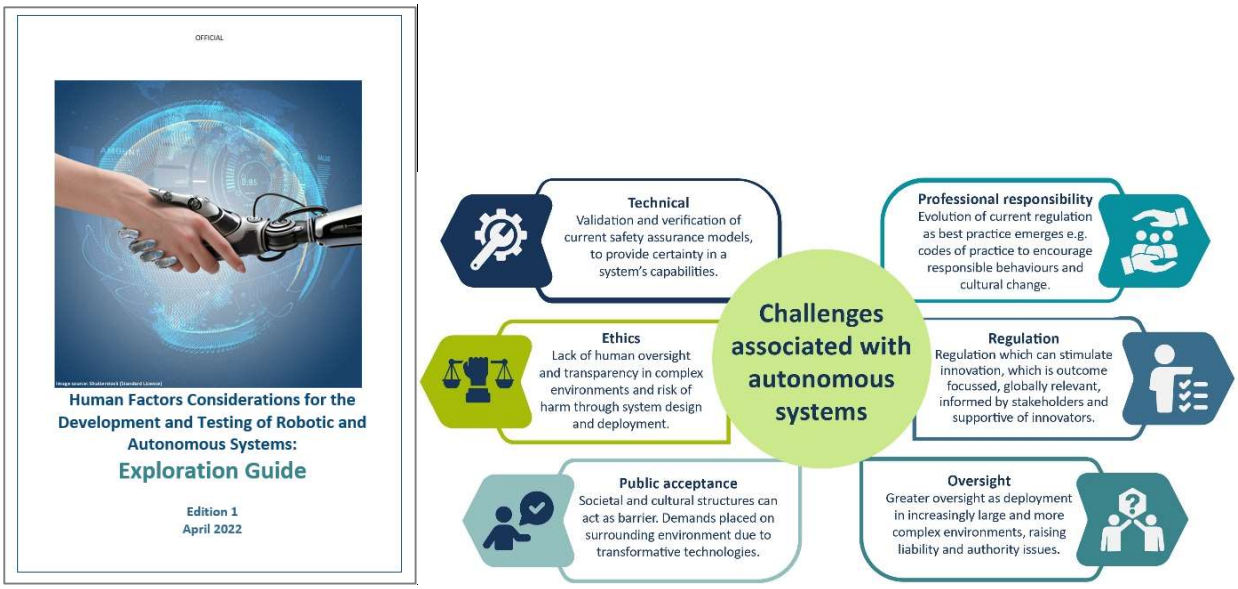

Figure 1: Exploitation Guide excerpts – front page and an example visualisation

RAS present a unique set of HF considerations over those that apply to other systems. The interaction between a human operator and a RAS is different from typical Human-Computer Interaction (HCI) as they may employ AI, involve complex dynamic control systems, exhibit high levels of autonomy and operate in changing real-world environments. This Exploration Guide provides high-level guidance to address many of these challenges and opportunities.

Who is the intended audience?

This Guide has been designed for use, primarily, by HF practitioners involved in developing, evaluating, acquiring and/or commissioning RAS. However, outside of this primary audience, it also provides useful contextual and awareness material for systems and software designers and engineers less familiar with basic HF approaches.

Exploitation

Work is in progress to exploit this output by uploading it onto the Knowledge in Defence Human Factors Integration Management System (HuFIMS) to sit alongside other Human Factors Technical Guides.