Uniting Human Data - A Warfighter Digital Twin Competences Framework

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Abstract - People competences encompass knowledge, skills, experiences, and behaviours that contribute to an individual's effective performance. These competences are crucial in personal development and in defining roles and responsibilities in recruitment, training, and career management. The question arises: Can this concept be similarly applied to warfighter digital twins? Digital twins, as digital replicas of physical entities, are established in various fields for simulation, integration, testing, monitoring, and maintenance. The growing field of human data capture, including biometrics, health, and career records, suggests the potential for creating human digital twins. In the military, a warfighter digital twin could span a career, aiding in recruitment, training, and career transitions. These digital twins could be integrated into training systems, assist in debriefings, and potentially cooperate or compete with their human counterparts. Future applications might see them incorporated into military equipment or platforms, but this raises significant autonomy, security, privacy, and ethical considerations. This paper, informed by recent research for the UK MoD and Home Office, examines the prospects and challenges of warfighter digital twins. It explores how existing employee competence frameworks might be adapted to these digital counterparts. A proposed framework would include the digital twin's knowledge, skills, responsibilities, limits of autonomy, interoperability with humans and other digital entities, and ethical considerations. Such a proposed framework aims to unite human data across multiple applications enhancing the management of warfighter data for training, career management, and equipment development.

1 Introduction

Terms such as data, AI, and digital twins are in the spotlight of simulation and training practitioners as they offer the prospect of a more quantitative approach to training and education, ultimately making it faster, cheaper and/or better. The author has worked on a number of recent research projects advising both the UK MoD Defence Science and Technology Laboratory (Dstl) and the UK Home Office. These research projects have included training data and evaluation, an eXtended Reality (XR) framework, and looking at the future of learning. They have all stressed the increasing importance of data and how developments are being driven for the most part by consumer technology. However, they have also highlighted that militaries do not have a systematic structured approach to such data and that there are significant privacy, ethical and security issues associated with this data.

Against this background, the author has drawn on other work including human competence-based interviews and previous digital twins research [1] to suggest that the two concepts might be combined to provide a more structured and consistent approach to warfighter personnel data. In doing so the author envisages that it could help start the conversation in this important area for learning and wider personnel management and the technology that supports it.

2 What is the Problem?

Recruiting and retaining warfighters is vital for military effectiveness, given the need to fill a vast array of roles, often on a large scale. The military workforce is typically young and serves in short, 2-3 year roles, within public sector pay constraints. Rapid global changes demand agility and adaptability in military operations, with an increasing need for digital proficiency in areas like cyber and space. The 2023 UK military's statistics illustrate the scale of this challenge: 142,500 regulars and 34,000 reserves, with substantial yearly turnover. The recent UK Defence Command Paper [2] (DCP) emphasizes the importance of adapting to a fast-changing world by prioritizing personnel, aligning career structures with modern aspirations. This includes promoting flexible 'zig-zag' careers, adaptable to the digital era's working styles. Personalized, data-driven learning is also a focus, enabling tailored skill development and effective readiness assessment. Accordingly, the DCP stated that “as a top priority, we will look to digitalise and simplify our whole force people system”.

Current (UK) digital systems in the military are however fragmented, making data access and technology integration challenging. As evidence, the Haythornthwaite Review [3] of the incentivisation of UK Armed Forces personnel stated that for MoD digital people systems “data is hard to access, technology is ageing, and …. a fractured ecosystem has created the need for manual workarounds … there is no single view of data across the Armed Forces.”

3 A Warfighter Digital Twin?

The defence sector, like many others, grapples with outdated personnel systems that are inefficient in data interaction and utilization. These systems often mirror the

military's complex and large-scale operations. However, there is an urgent need for defence to transition from this fragmented ecosystem. A potential solution lies in envisioning a future centred on a warfighter digital twin.

The term "digital twin" itself refers to a digital replica of a physical entity, aimed at real-time monitoring and optimization. Definitions vary, with Wikipedia presenting it as “a virtual representation that serves as the real-time digital counterpart of a physical object or process” [4], while the built environment services firm ARUP [5] describes it as a combination of a computational model and a real-world system, capable of learning and adapting. We will assume here that a digital twin encompasses a modelled object(s), associated data, data updates, and a link to an existing physical entity. Further, our warfighter will be that physical entity and their data linked both synchronously and asynchronously to the warfighter digital twin. Synchronous data might be from a wearable device and asynchronous data might be an exam result.

The proposed warfighter digital twin will exist through career. It would be established for a warfighter right from their initial interest in the military. This digital counterpart would be a constant through their career, facilitating seamless transitions between recruitment, training, and active service. It would support the warfighter in adapting to various roles, minimizing skill decay, and navigating through 'zig-zag' career paths. Furthermore, these digital twins could be integrated into training systems, assist in debriefings, and potentially cooperate or compete with their human counterparts. Data would flow backwards and forwards between the warfighter and their digital twin, so data is always up to date.

This system would not only benefit the individual warfighter but also provide commanders and operational planners with comprehensive dashboards. These tools could offer insights into the readiness of personnel for specific roles, the impact of their training, and overall unit preparedness. While the integration of such digital systems would undoubtedly raise concerns regarding security and privacy, and challenge existing organizational approaches, it holds the promise of enhancing personnel management in defence. Through a warfighter digital twin defence could achieve a more unified and effective approach to managing its people, aligning with the evolving technological landscape and operational demands.

A warfighter digital twin also offers a practical tool in military equipment development and deployment. It could support the testing and refinement of military equipment and systems under various scenarios identifying potential equipment malfunctions or inefficiencies before actual deployment. Additionally, it could facilitate the analysis of how different equipment affects soldier performance and endurance. By enabling virtual trials, the digital twin could contribute to more informed decisions in equipment design, leading to improved functionality and compatibility with warfighter’s needs.

4 Human Competences

In personnel management, competences are the specific set of knowledge, skills, experiences, and behaviours that are necessary for effective performance in various job roles. They serve as a framework for identifying the necessary attributes an employee needs to excel in their position. These competences may include technical skills, which are specific to a particular job, as well as soft skills like communication, teamwork, and problem-solving, which are universally valuable across different roles.

By defining competences, organisations can streamline various HR processes, such as recruitment, where they provide a clear criterion for what is expected from candidates. In training and development, competences help in identifying areas where employees may need improvement or additional learning. For performance evaluations, competences offer objective criteria to assess employee effectiveness and contributions. Ultimately, a well-structured competency framework aids in aligning individual performances with the organization's strategic objectives.

The author has had direct experience of such competences, First as an employee and line manager and more recently conducting competence-based interviews for Chartered Engineers. In the latter case this has involved chairing and co-chairing some 200 interviews and subsequently overseeing the running of a further 240 for the Institution of Mechanical Engineers (IMechE). It is this experience that inspired the concept of the warfighter digital twin competence framework. This is because although the competence framework is specifically for engineers it works for a very broad range of occupations across the world, including for military personnel. Other competence frameworks could be chosen but this is where the experience of the author lies, and the framework will be discussed in more detail in the next section.

5 Competence Frameworks

Each competence framework will inevitably be linked to the occupation but there are generic examples [6]. The Leadership Competency Framework encapsulates capabilities such as strategic planning, effective decision-making, and the adeptness to motivate and lead teams. Similarly, the Technical Competency Framework is used in fields that require specialized technical knowledge, such as information technology or engineering. This framework accentuates competencies in technical problem-solving and proficiency in industry-specific tools. It has not been possible to find specific military examples but the US Army for example identifies “essential characteristics” which are Trust, Honorable Service, Military Expertise, Stewardship, and Esprit de Corps [7].

Standards for Simulation Training

As discussed earlier, the author has selected the IMechE competence framework due to significant experience in applying it. The IMechE framework is derived from the wider UK Engineering Council framework [8] and has five main competences as follows in table 1.

Table 1. IMechE Competence Framework.

	Description
A	**Knowledge and understanding** Formal training, learning new engineering knowledge across industries, understanding emerging technologies, and developing innovative technological solutions to complex problems.
B	**Design, development and solving engineering problems**. Identifying and conducting investigations and research for engineering tasks; evaluating and implementing solutions, learning from feedback for continuous improvement.
C	**Responsibility, management, and leadership.** Planning and managing engineering tasks, including budgeting, risk assessment, and stakeholder negotiation; leading teams and promoting continuous quality improvement.
D	**Communication and interpersonal skills.** Effectively communicating complex information and proposals in English, demonstrating interpersonal skills, and showing awareness of diversity and inclusion.
E	**Personal and professional commitment.** Adhering to relevant codes of conduct, managing safety and sustainable development in work, engaging in continuous professional development, and upholding ethical responsibilities.

For the assessment of competences, the applicant is scored as described in table 2. Any score of Level 1 means that the applicant is unsuccessful as they must show a minimum level of competence (2) across the board. They must also be Level 3 for a minimum of any three of the competences.

Table 2. IMechE Competence Scoring Structure.

Level	Explanation
Level 4 Expert	Performs activity in a wide range of complex or non-routine contexts. Substantial personal autonomy - can develop others within the activity.
Level 3 Skilled	Performs activity in a range of contexts, supervision required in more complex circumstances. Significant responsibility and autonomy - can oversee the work of others.
Level 2 Familiar	Performs activity in some complex or non-routine contexts. Some individual responsibility or autonomy.
Level 1 Aware	Performs activity with significant supervision & guidance. Performs basic routine tasks, little / no responsibility.

6 A Warfighter Digital Twin Framework

A digital twin of the warfighter will hold all the key data relevant to its human warfighter twin. It will be legacy data as well as real time data and the digital twin will need to interface with many digital systems such as recruitment, career management and training and education. It may also need to exist after the warfighter has left the service, for example for medical record reasons or if they return to service as part of their “zig zag” career. In table 3 is a proposed warfighter digital twin framework based on the IMechE framework of table 1. The competence headings have been changed to better reflect the nature of the digital twin.

Table 3. Proposed Warfighter Digital Twin Competence Framework.

	Description
A	**Knowledge, Skills and Medical/Physical Attributes.** Captures the knowledge and skills of the warfighter through career and their development plans including legacy and real time data and used to create the digital avatar of the warfighter
B	**Applying Knowledge and Skills**. Expresses what activities the warfighter is qualified and not qualified to do and their adaptability.
C	**Responsibility and Autonomy.** Expresses the risk of the warfighter’s activities, for example in terms of operational impact, safety, and cost, and the level of risk that the warfighter can hold and the degree to which they can act autonomously.
D	**Communication.** Expresses how and what the warfighter digital twin will interface/communicate with, including digital systems, other digital twins and with human warfighter(s) including any technical and process standards.
E	**Privacy, Security and Ethics.** Determines the access to the warfighter data and rules by which it is controlled and managed, including what it can and cannot be used for.

The competences are of course tightly interrelated, and the overall status will determine what the digital twin can and cannot be used for. As an example, if the digital twin is being used as career development tool, then it would not necessarily need to be highly developed across all competences. However, if it is to be used in a training system as an opposing entity say or in control of an actual autonomous system then it is likely to need to be highly robust across all five competences. Table 4 suggests how the digital twin might be assessed and scored. It is important to stress that this assessment of the digital twin is not necessarily a reflection of the human warfighter as the human may be highly capable, but the digital twin has not been tested and verified as highly capable.

Table 4. Proposed Warfighter Digital Twin Competence Scoring.

Level	Explanation
Level 4 Expert	Performs role in a wide range of complex or non-routine contexts with high levels of autonomy.
Level 3 Skilled	Performs role in a range of contexts, human supervision required in more complex circumstances.
Level 2 Familiar	Performs role in some complex or non-routine contexts but requires supervision & guidance.
Level 1 Aware	Performs basic routine tasks, little / no responsibility and requires significant supervision & guidance.

Interestingly, previous research determined that although there is no definitive definition of autonomy, for example for automobiles and robots, four levels have also been defined. The DoD Unmanned Systems Integrated Roadmap FY2011-2036 defined four levels from "Human operated", to "Human delegated", "Human supervised", through to "Fully Autonomous". However, defined, it will be important to get good agreement on the warfighter digital twin levels, especially when used in high-risk settings.

7 Opportunities and Challenges

A warfighter digital twin could serve as a powerful tool for training and education, and in equipment development, with the potential for incorporation in autonomous systems. It also offers the opportunity to help bring disparate human resource digital systems together and provide through career support to both the warfighter individual and the wider enterprise. The proposed framework is intended to inspire discussion and debate about such a warfighter digital twin. It is perhaps worth stressing that the direction of travel is towards exploiting warfighter data and for organisations to "do nothing" means that the fragmentation of digital systems and less than optimum exploitation of data will only get worse.

However, there are very many privacy and ethical issues in the management and retention of warfighter data; when the warfighter has a "bad day" in training for maybe personal reasons is this data retained for ever? Also, there may well be limits as to the amount of data retained; it is likely to be impractical to retain all data from every training event for example. Although data storage continues to become less costly, decisions will need to be made around what data needs to be retained and for how long. Security may become more problematic also as the aggregation of data may raise classification levels. Overall, data management will be more challenging, but one might argue that this is a good thing as data becomes increasingly important across all aspects of defence.

The author suggests that although establishing warfighter digital twins does have significant challenges, "do nothing" is not an option for managing warfighter data on an enterprise basis.

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Andy Fawkes is an independent consultant, writer and engineer working in the field of simulation and training. He previously presented at IT2EC 2022 "My Digital Sibling" and at IT2EC 2024 "From SIMNET to the Metaverse - Why is it taking so long?". He is Special Correspondent for Military Simulation & Training (MS&T) and a Fellow of the Institution of Mechanical Engineers (FIMechE). Formerly he was head of simulation policy for the UK MoD and Chair of the NATO M&S Group.