

# Understanding the Future Electromagnetic Environment Through a Futures Thinking Approach

Matthew Webster, Ella-Mae Hubbard, Chinthana Panagamuwa & James Flint

Electromagnetic Environment Hub, Loughborough University, UK

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## SUMMARY

To understand the human factors implications for the ‘Generation After Next’, particularly for decision making in electromagnetic warfare, a futures thinking approach is applied. It investigates three electromagnetic environment horizons, (emerging, next generation and generation after next) with the aim to understand what types of decisions an electromagnetic warfare operator might perform. The purpose of this study is to improve the performance of both military individuals and teams, by assisting in the development of new decision support systems.

## KEYWORDS

Electromagnetic Environment, Defence, Decision Making

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## Introduction

The military performs operations within the Electromagnetic Environment (EME) which aims to utilise the Electromagnetic Spectrum (EMS) through an operation known as Electromagnetic Warfare (EW). EW covers the domains of land, sea, cyber, space and air, and is split into three core components (MoD & DCDC, 2018);

- **Electromagnetic Attack (EA):** This uses Electromagnetic (EM) energy for offensive purposes i.e. disrupting and destroying signals. When used it diminishes an enemy’s ability to understand, shape or exploit the operational environment (EME).
- **Electromagnetic Defence (ED):** This uses EM energy to provide protection and ensure effective friendly use of the EMS i.e. prevents receivers from being jammed.
- **Electromagnetic Surveillance (ES):** This uses EM energy to provide situation awareness and intelligence i.e. provide a better picture to the commander and intelligence analysts to decide the next course of action.

EW covers the congested space occupied of both civilian and military users, and it is up to the operators to utilise their skills and decision-making systems to make decisions on whether any electromagnetic activity is developing into a threat that requires them to attack, intercept or protect either domain.

Recently, there has been a focus on the Generation After Next (GAN). The MoD defines the GAN as the following; “Generation-after-next is capability that does not exist and contributing technology is not fully understood.” (MoD, 2024). The Human Factors (HF) contextual question that keeps arising is: what does the future look like for a human (EW operator). Therefore, it’s important to investigate and begin to understand the types of decisions and challenges an operator will face, including what types of technology might be available.

What makes the GAN concept so challenging is not knowing when that horizon will be. It is easy to consider potential scenarios and develop recommendations based on these assumptions. As technology advances over the coming decades, there is the risk that these assumptions will change and potentially be outdated. This leaves us with having designed concepts for what we thought was GAN but, in fact, they are designed for a much closer timeframe. Predicting the types of technology, and how humans will interact with it, is therefore difficult. There are methods that can be tested in order to bridge the gap between these seemingly impossible timeframes. This is through a concept called 'Futures Thinking', a strategic approach that explores and considers future scenarios. It provides the relevant personnel with the capacity to proactively anticipate changes (Canina, Bruno and Monestier, 2022).

## Method

The Government for Science 'Three Horizons' tool fits best to this research (Government Office for Science et al, 2024) as it aims to provide a framework that thinks about the future when considering an unknown future. In this case, helping to understanding what the future looks like for an EW operator. This method was adapted to create a smoother approach to the Futures Thinking method, by adopting a stair ladder methodology developed as part of this work.

Three present day EW scenarios were developed: a drone attack, a natural disaster and a recovery mission. The adapted approach allowed participants to build on a present-day scenario and explain what that might look across a series of time horizons by building on the previous time horizon. Three time horizons were developed to help bridge the gap between present day and the GAN;

- **Emerging (E):** Advanced application of technologies and ideas (familiar today).
- **Next Generation (NG):** Advanced and integrated application of cutting-edge technologies and unknown technological advances against E themes (advanced autonomy).
- **Generation After Next (GAN):** Highly sophisticated application of current unknown technology and trends.

The study took place at two locations; the 2024 Operating in the Future Electromagnetic Environment Symposium (OFEME) and a Defence MSc module at Loughborough University. Each workshop lasted 1.5 hours (2x OFEME, 1x Loughborough). In total, 60 people took part (Workshop 1 = 25, Workshop 2 = 21 and Workshop 3 = 14). The age ranges varied from 18 – 64. Participants ranged from scientists, engineers to military personnel within the EME / EW.

For the analysis, this study presents a consideration for utilising a Thematic Analysis hybrid approach using both inductive and semantic approaches when developing themes and sub themes.

## Results / Findings

Table 1: Futures Thinking Thematic Analysis Results

Scenario	Themes	Sub Themes	Horizons Represented Across Sub Themes (%)			Key words
			<i>E</i>	<i>NG</i>	<i>GAN</i>	
<b>Drone Attack</b>	9	61	35%	34%	31%	171
<b>Natural Disaster</b>	11	90	34%	27%	38%	199
<b>Recovery Mission</b>	9	57	36%	27%	37%	110

Each scenario had a completely different focus: natural disaster, drone attack, recovery mission. Despite this, there were common themes amongst the three scenarios. This implied theoretical framework themes within the future of EW can be signified: Automation, Ethical, Human Required, Military Systems and Processes, Operator Processes and Technology Systems. Across the three

scenarios, some examples of sub-themes that highlight both positive and negative aspects for the future of EW and what it might look like for an EW operator are showed below.

**Positive:** Upgraded military systems, Better Understanding, Improved trust, reactions and confidence.

**Negative:** Ethical concerns, Changes to missions processes and procedures, Assurance challenges, Loss of operator skills and knowledge, Changes to operator role and training changes, Risk of overwhelm, Underestimation and Distraction.

**Themes to that might affect an EW operator in the future:** Automated Systems (E,NG,GAN), AI, Visualisation of Data and Operating picture changes, Increased number of enemies, Removal of humans, Congested EM.

**Future Technology:** Quantum, Artificial Intelligence (AI).

**Future Technology Challenges:** Technology blackouts, More power needed, Technology poisoning wars.

## Conclusions

This study aimed to investigate what the future EW might look like for an operator through an adapted futures thinking approach. Creating a stair ladder approach to build on the previous horizon has helped to bridge the gap between now and a distant future and applying this method to three relevant but different scenarios has helped to understand the different decisions and challenges operators may face in the future, both positively and negatively, including future technology and its challenges.

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