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The Fundamentals of Test & Evaluation in Defence

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Living in a world that is ever changing, with rapidly advancing technology and unpredictable external global influences challenging our lives every day, we want to take the opportunity to remind ourselves of the fundamentals of our core business: Test & Evaluation. Why do we do T&E and how do approaches have to evolve constantly to meet the future requirements of our customers globally?

Why is Test & Evaluation so important in Defence?

At the highest level, Test & Evaluation (T&E) aims to provide customers with an evidence base that allows them to make well-informed, objective decisions in relation to a Defence capability.

Broadly speaking, there are 3 reasons to do T&E in Defence:

- To assure a capability is safe
- To assure a capability is contractually compliant (i.e. the buyer gets what they want, and what they paid for)
- To assure that a capability delivers on what the end-user of that capability wants it to do

Who benefits from carrying out Test & Evaluation?

In short, everyone involved in the process of bringing a capability into operation for the advantage of frontline commands, benefits from doing T&E.

First to benefit is the manufacturer: who can use T&E to understand the options available to them early in the development process, gather the evidence to support their technical submission for contractual acceptance and understand the upgrade options once a capability has been fielded and used. This ensures that costs can be more closely managed, that the capability remains relevant, and it reveals how it can be adapted to other uses.

As such, T&E allows the end-user to manage risk earlier, which can reduce programme costs and development times. Additionally, it provides assurance that the capability will be compliant with legal requirements and the rules of engagement.

Second to benefit is the procurement agency: who can be sure that they are getting an asset that is safe, and that meets specific requirements - relative to costs and investment. In other words, that the capability provides value for money.

Third to benefit is the end-user: be this the soldier, sailor, marine or airman/airwoman. With proper T&E, the end-user can be sure that the capability will meet their operational requirements and that it is safe to use. They also have an idea of what it is capable of, and how it will behave in different circumstances.

How do we carry out Test & Evaluation?

At a high level, T&E is an application of scientific method; hypothesise, design a cost-effective trials programme to test the hypothesis, refine the system design based on this evidence and test again.

Key to this, therefore, is to understand what quality of evidence is needed to verify or validate a requirement. This allows us to plan the most cost-effective means of gathering that evidence. Options include engineering judgment, the use of historical data, modelling and simulation and live trials.

In T&E, we evaluate the fitness of a system's various elements for safety and performance. If a shortfall is found (and has a significant impact on the desired operational capability) a re-design may be called for. Such early discoveries save lives and resources in the long-term.

Another point of interest is the 'digital thread', the single evolving repository of data that follows the capability through life. The thread provides a single source of safety and performance evidence - allowing for decisions and data re-use throughout the life of the platform (ship, plane or tank, for example), and how that platform supports delivering a military effect.

How long does a typical Test & Evaluation trial take?

The range of a typical trial is hard to put a number to. With a few exceptions (usually associated with life and reliability), specific test events are relatively short.

For example, a trial that tests the efficacy of a weapon could last a few hours - accounting for the preparation and firing of the weapon, and the after-action review. An accelerated ageing trial that tests the effects of prolonged vibration on that same weapon could last for months.

And, as part of a whole-of-life process - the through life trial programme could last for decades, from initial concept testing, to acceptance testing, to operational testing (once in service), progressively populating the evaluation strand of the digital thread.

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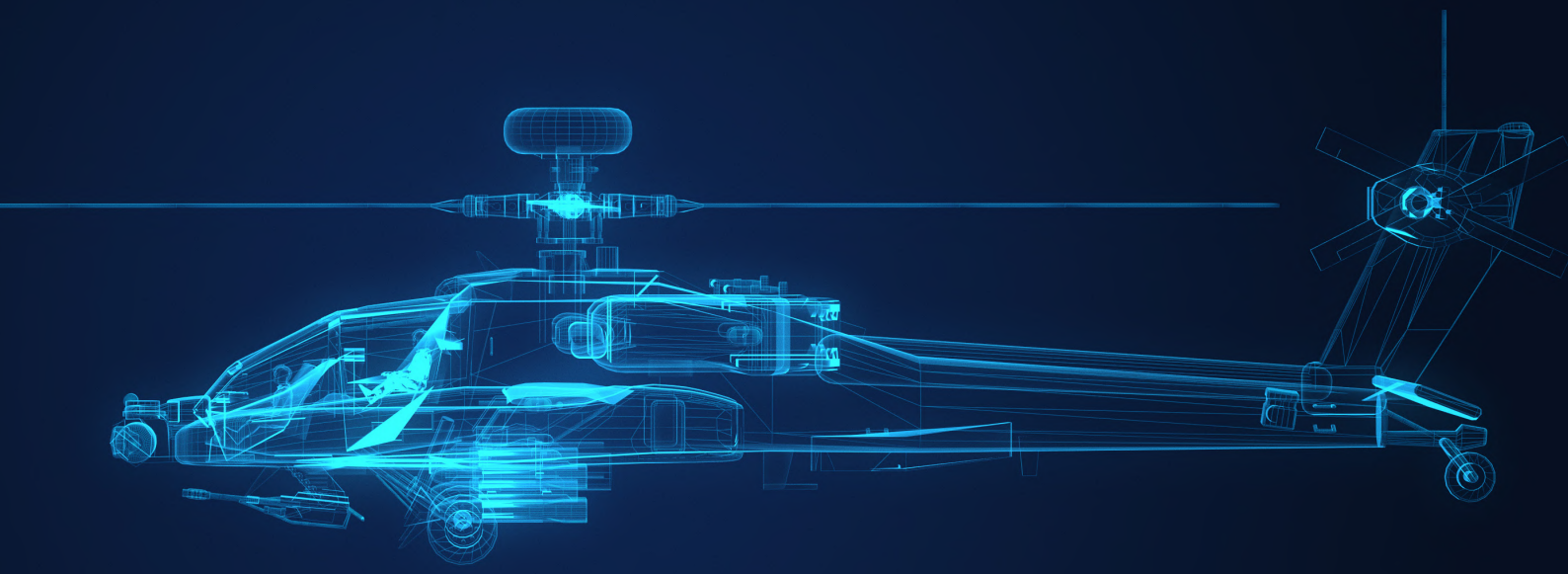

When should you embark on Test & Evaluation in Defence?

At its core, T&E is about capturing issues that may be experienced in operation. If you test too late in the programme, errors may manifest only when you're faced with an operational threat, putting lives at risk, or become very expensive to fix. As such, it is essential to embark upon T&E right from the beginning of the development of the capability. Typically this has a strong focus on the platform but should also include other related elements needed to deliver the capability such as fitness of a training solution if needed. It should then continue with it all the way to the end of its useful service life.

In the UK as an example, the policy is that T&E planning starts during the concept phase and continues through the life of the capability. By starting early in the capabilities lifecycle, we can identify and implement new kinds of evaluation techniques including tests, and test facilities, that it might require throughout its service life.

Where is Test & Evaluation carried out?

Currently, the most effective T&E takes place in the physical world, however this is becoming increasingly challenging and can be very expensive - depending on what is being tested.

Modern defence programmes use increasingly sophisticated digital models and simulations. Where possible (and if suitably validated) these can be used to provide the required evidence. The essential role of live testing then becomes one of validation of the models, and, if needed, final acceptance testing - giving the customer ultimate confidence in the delivered product.

Such environments also open up a more creative approach to gathering evidence - by providing more options. For example, you can test under conditions that would be impossible to replicate live - for practical, cost or security reasons.

Although the use of model and simulation has been used for many years to design defence equipment (with the corresponding reduction in live trials) there is now an emerging convergence between the models used for development, and the 'digital twin' of the platform developed for in-service support.

A digital twin is a virtual model of a process, product, or service, built alongside, and the digital thread is ultimately paired with the physical asset when in service. As the reference artifacts for the platform and capability, they allow us to explore the impact updates and stimuli, before committing the time and money to build it in the real world.

In due course, it is expected that development models will progressively evolve into the corresponding digital twin. Currently, bespoke models are developed as needed and then discarded, particularly in the early stages of development. In the future, we're likely to see a more integrated, though-life model development strategy. As such, early models will see use all the way to the end of the development process - and, once the asset enters service, these models will become the product digital twin.

However, using modelling and simulation for T&E may require a mindset shift about what we accept as evidence. Though the technology has existed for decades, many safety agencies still insist upon physical testing in order to sign off on a project. This is finally starting to change.

All that said, operationally gathered evidence always has been and always will be paramount.

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Case study: Air

'Centurion' was the capability transfer from the Tornado to Typhoon. It entailed the migration of Brimstone and Storm Shadow weapon systems, plus the introduction of the new Meteor weapon system, along with some avionic upgrades. It was incredibly time-sensitive, and required in advance of Tornado's fast-approaching out-of-service date.

However, one of the complexities of Typhoon being part of a 4-nation project is that the core programme that did most of the work was moving too slowly to realise Centurion's UK-specific requirements.

QinetiQ's engineering experts stepped in, working with the RAF Air & Space Warfare Centre's test pilots to evaluate the evidence at an earlier stage. Where the previous time horizon for the evaluation was over six months, QinetiQ's intervention compressed the remaining work down to just four weeks.

If not for this intervention, there could have been months of delay before the RAF could commence its own evaluation of the new systems. Ultimately, this created an enormous time, risk and cost saving for the Ministry of Defence, whilst helping to protect Tornado's out-of-service date.

Case study: Land

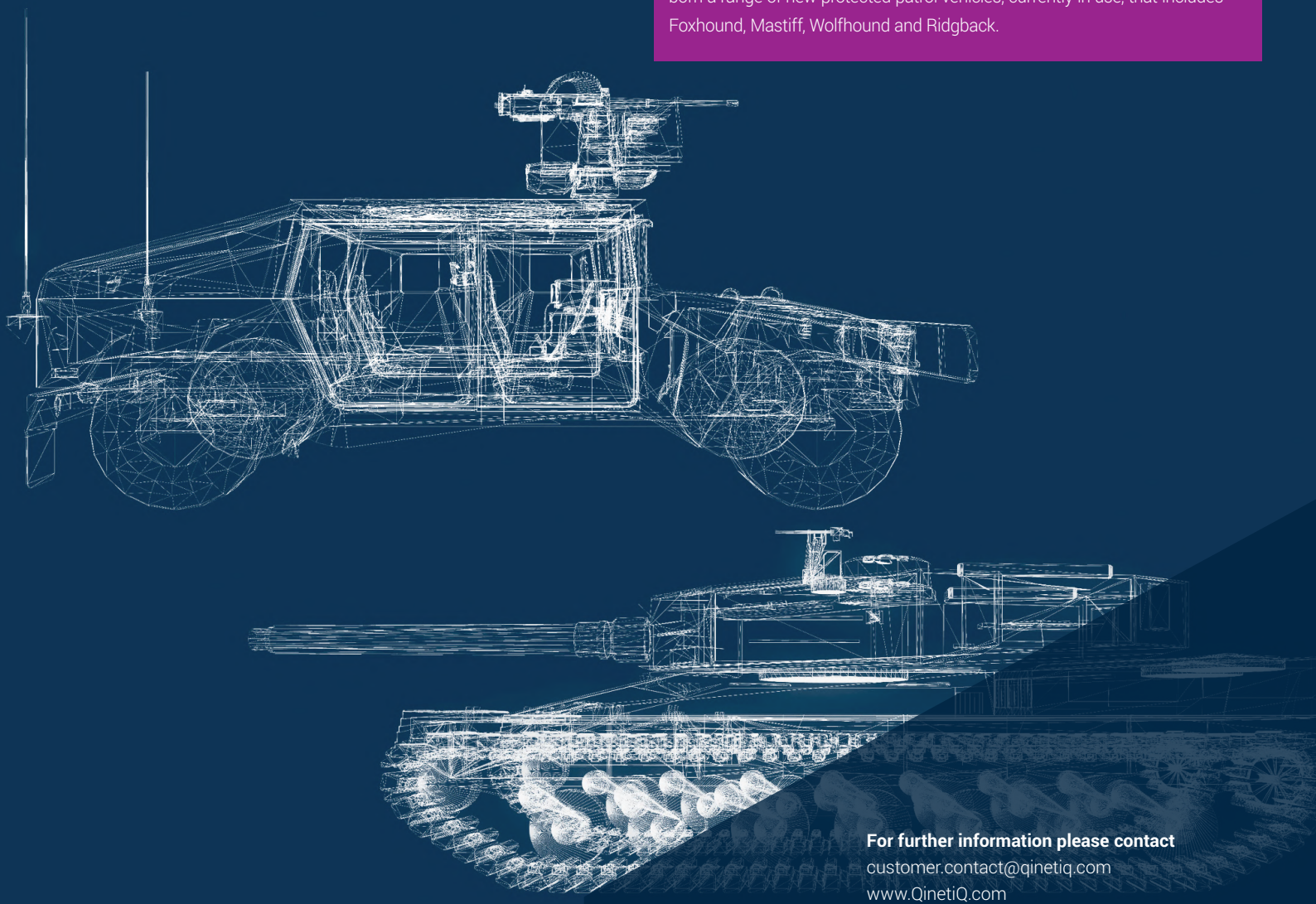
Our final example is the MOD's urgent operational requirement (UOR) that came about in the late 2000s, in response to the growing threats from IEDs and mines in Iraq and Afghanistan.

The patrol vehicles in use at the time were ill-suited to this environment - such craft were either fast, agile and insignificantly armoured against such explosives - or better protected, but slow and expensive to operate. As such, the death toll and the political pressure were significant.

Existing capabilities included the Warrior IFV, a vehicle that was first introduced in 1987. Another was the Snatch Land Rover, an up-armoured version of the Land Rover Defender 110, originally envisioned for lighter duty missions in Northern Ireland, and for peacekeeping.

The requirement was for a series of new platforms and platform upgrades that offered increased resilience to these explosive threats - whilst still maintaining the mobility required to operate in the varying terrains of Iraq and Afghanistan. Replacements had to be fielded as quickly and safely possible.

New, hardened vehicle designs were developed, but these required testing prior to acceptance into service. A series of tests, comprising a representative threat and environment, were established at MOD Eskmeals, proving the ability of the vehicles to protect their occupants from these threats. Out of this UOR was born a range of new protected patrol vehicles, currently in use, that includes Foxhound, Mastiff, Wolfhound and Ridgback.



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