Ministry of Defence

Defence Experimentation for Force Development Handbook

Version 2

Defence Experimentation for Force Development Handbook

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Director Development, Concepts and Doctrine Centre

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Foreword

The strategic context is increasingly complex, dynamic and competitive. We face diversifying, intensifying and proliferating threats from revanchist and rising powers, and from non-state actors such as violent extremists. We must acknowledge we are in state of persistent competition – the fifth 'C' of modern deterrence – and as threats and opportunities continue to evolve, so too must we. More of the same will not be enough.

A vital part of our response, and one that will help to maximise the effectiveness of our Armed Forces, is continuous and iterative experimentation driven by priorities set by the Defence Force Development Board. Under the banner of Integrated Warrior, we will bring alignment, rigour and efficiency to this pan-Defence experimentation activity. Do this well and it will support our determination to take a more threat-informed, concept-led approach to Force Development; one that places greater emphasis on the role of evidence and critical thinking in our decision-making processes. Critically, experimentation will help test and prove the physical and conceptual manifestations of our concepts, gear these answers to investment decisions, and promote faster insertion of new capability. Experimentation – through new ways and means – can therefore sharpen 'our edge' and deterrent effect and help maintain a 'theory of winning' as we look ahead to new challenges and opportunities.

Our people lie at the heart of experimentation and it requires a 'Whole Force' effort across the spectrum of Force Development activity. Partners beyond Defence, particularly industry, academia and allies, will offer innovative ideas and capabilities, and help us to challenge accepted routines, special interests and cultural norms. And as there is no 'fixed destination' or final move in our goal to modernise and transform, we must encourage a habitually adaptive mindset throughout Defence to help drive rapid exploitation as opportunities become clear. In so doing, we will have to take risk and accept some failure.

The *Defence Experimentation for Force Development Handbook* provides an important guide for the governance, approach and exploitation of experimentation. It is an important contribution to the Defence Force Development process and to building a culture that promotes challenge and better performance. It will be of value to anyone engaged in experimentation and Force Development activity. I commend it to you.

Admiral Tim Fraser CB ADC
Vice Chief of the Defence Staff

Preface

Purpose

1. The purpose of this *Defence Experimentation for Force Development Handbook* is to articulate Defence's approach to 'Defence Experimentation' in support of Force Development. This handbook provides those engaged in Force Development with information on why and how Defence Experimentation should be used to support their activities. The handbook serves as a reference for the governance, management and exploitation of Defence Experimentation, aimed at sponsors of experimentation requirements. It is not a detailed manual for designing and delivering Defence Experimentation; alternative reference sources for guidance on experimentation are provided.

Context

2. Defence Force Development (DFD) is the overarching process by which Defence seeks to deliver effective and coherent Defence capabilities that are threat-informed, concept-driven, technology-enabled, policy-aware, resource-aligned and evidence-based. Defence Experimentation is critical to supporting and enabling activities for DFD. The principal benefit of this approach is that it provides evidence to guide our capability decisions in the near, medium and long term. By doing so, we ensure the force can adapt with suitable agility to meet the challenges of today and the future within an ever-evolving operating environment. This can only be achieved through the timely exploration of ideas or problems and generating evidence that enables effective decisions and choices. The principal purpose of Defence Experimentation is to generate timely, coherent evidence to inform Force Development activities and decisions across the entire spectrum of DFD.

Audience

3. The *Defence Experimentation for Force Development Handbook* is primarily intended to assist Defence personnel who have Force

Development and experimentation as part of their responsibilities, but also to provide broader understanding to staff in policy and strategy formulation; science and technology; capability development, innovation and acquisition; and also to operational commanders and their staffs. Members of other government departments, industry, academia and allies with whom Defence personnel are likely to engage are also encouraged to refer to this handbook.

Structure

4. The *Defence Experimentation for Force Development Handbook* consists of three chapters and a suite of annexes.

- Chapter 1 describes DFD, the drivers that impact it and the integral need for, and role of, experimentation.
- Chapter 2 describes Defence Experimentation and the framework for managing experimentation requirements to provide coherence and awareness across Defence.
- Chapter 3 describes how Defence Experimentation activity is governed, managed and coordinated, including alignment with DFD priorities set within the Defence Plan.
- Annex A provides supporting detail on the DFD approach, principles and goals, and activities in the context of Defence Experimentation.
- Annex B provides a selection of Defence Experimentation techniques.
- Annex C provides information on the evidence framework.
- Annex D provides a select list of bibliography/reference documents for further reading.

- The lexicon provides a list of select definitions and compares key United States Department of Defense and UK Ministry of Defence terms relating to Force Development.

Linkages

5. This handbook will be reviewed as a result of periodic learning and revision; a first revision is due in summer 2021. The handbook should be read in conjunction with the *Defence Force Development Handbook*; the Development Concepts and Doctrine Centre's (DCDC) *Wargaming Handbook*; and DCDC's *Red Teaming Guide*. Other useful references are listed at Annex D. There is an overview of the Defence Experimentation Management Information System available as a separate document sitting alongside this publication.

Contents

> If we can establish a scientific method of examining war, then frequently shall we be able to predict events – future events – from past events, and so extract the nature and requirements of the next war possibly years before it is fought.
>
> Major General J.F.C. Fuller

Chapter 1

Force Development and experimentation

Section 1 – Defence Force Development

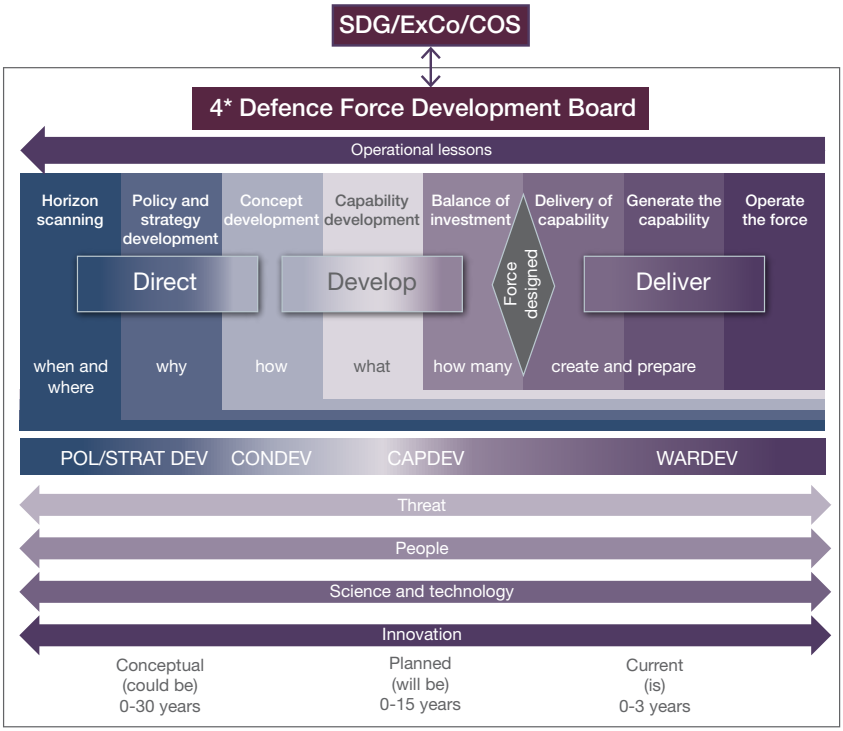
1.1. **Force Development.** The aim of Force Development is to produce forces that are fit for purpose, resilient and sustainable to meet current and future challenges. This involves having a clear understanding of the status of the current force (where we are now) and a clear indication of where we need to be at (the end), whilst understanding the future threats and opportunities. The challenge today is that the end is constantly shifting and at an increasing pace. Consequently, an approach is required that enables a clear understanding of the required trajectory for Force Development. Acknowledging that our designed forces will always require adaptation to meet operational demands, they must also have the agility to make course corrections through informed decisions based on evidence that guides the path for future force design and its associated capabilities. An incremental update of equipment

approach to Force Development that has worked in the past will no longer guarantee advantage in the future. Consequently, our approach to Force Development must change; it must direct forward thinking with consideration to 'a system-of-systems' approach, exploration and experimentation of new and extant capabilities, support strategy and shape the trajectory of force design.

1.2. **A new approach.** The Defence Force Development (DFD) initiative was established to address a range of problems identified within our current approach to Force Development. These problems included:

- a need to inform evidence-based balance of investment decisions within Defence;
- providing a clear link between concepts and capability;
- enabling agility and adaptation;
- identifying and exploiting opportunities, including technology and innovation; and
- integrating challenge and experimentation into Force Development thinking and processes.

1.3. **Defence Force Development.** DFD seeks to deliver effective and coherent capabilities for Defence that are threat-informed, concept-driven, technology-enabled, policy-aware, resource-aligned and evidence-based. The principal benefit of this approach is to provide evidence to guide our capability decisions and ensure the force has the necessary flexibility to meet the challenges of the future operating environment. This can only be achieved through the timely exploration of problems and generating evidence that supports decisions and choices about what we need to achieve (policy and strategy development); how our forces might operate and use extant and new capabilities (concept development); and how effects will be created (capability development and warfare development), including the transition to operational and tactical doctrine. The DFD model, as depicted at Figure 1.1, is explained in detail at Annex A.



COS	Chiefs of Staff	POL/STRAT DEV	policy and strategy development
CAPDEV	capability development	SDG	Strategy Development Group
CONDEV	concept development	WARDEV	warfare development
ExCo	Executive Committee		

Figure 1.1 – Defence Force Development model

concept development (CONDEV)

The application of a deliberate methodology to explore, understand and define Defence problems, determine possible solutions that guide how forces will operate and influence the policies and capabilities that are required to enable the force to achieve success.

(*DFD Blue Print*, 2019)

capability development (CAPDEV)

The translation of operating, domain, functional and thematic concepts, in line with Defence Strategic Direction and the Defence Plan, to develop and deliver military capability. The process assesses and bridges the gap between existing and future capabilities. Capability options are presented for balance of investment decision-making and result in the force design.

(*Defence Operating Model*, 2019)

warfare development (WARDEV)

The synthesis of operational analysis and lessons identified through the observation of operations, training and exercises; doctrinal and technological developments, and capability integration and experimentation across all military operating domains.

(*DFD Blue Print*, 2019)

1.4. **Understanding the Defence Force Development model.** The DFD model is an evolutionary process that encompasses incremental and disruptive changes; it should not be viewed as a simple, linear, end-to-end process. Interrelated activity takes place concurrently in all of the functional areas.[1] The model, with aligned processes and governance structures, provides the mechanisms to direct a more responsive and adaptive approach to Force Development. Along with experimentation, it will support the development of underpinning evidence and greater linkage and traceability between our concepts and capability strategies,

1 Policy and strategy development; concept development; capability development; and warfare development.

and requirements that meet our aspiration of the force structure. DFD provides this by:

- enabling better coordination and allowing threats and opportunities to be prioritised and addressed with agility;
- assuring the linkage between concepts and capabilities through early analysis and generating concept implementation plans;
- prioritising and directing Force Development experimentation and innovation activities, resulting in better informed Force Development decisions;
- clarifying roles and responsibilities;
- codifying how we do Force Development; and
- enhancing information flows to put the whole of Defence into a Force Development mindset.

1.5. **Defence Force Development governance.** DFD governance is delivered through a series of boards, as illustrated in Figure 1.2, and mechanisms that subsume, replace or simplify existing structures. The governance structure provides effective oversight and direction across the full range of policy, conceptual, capability and warfare development processes. The DFD Board (DFDB), chaired by Vice Chief of the Defence Staff, will take direction from the Strategy Development Group to inform capability areas that require investigation. There will also be strong linkages with a broad range of other 3* and 4* boards including, but not restricted to, the Defence Technology and Innovation Board (DTIB), People Committee, and the Digital and Information Board. The DFDB will direct activity across the full spectrum of Force Development, providing direction for implementing DFD across Defence. The DFDB will be supported by three 3* pillars centred on the:

- **Integrated Concepts Board,** chaired by Director General Joint Force Development;

- **Military Capability Board,** chaired by Deputy Chief of the Defence Staff (Military Capability); and

- **Operational and Policy Requirements Group,** under the Joint Commitments Strategic Steering Group, chaired by Deputy Chief of the Defence Staff (Military Strategy and Operations).

This 3*-level governance structure will provide the direction and focus within specific areas of the DFD model, as well as assuring continuity of activity and transition as the force design matures through concept, capability and warfare development, and subsequently into doctrine.

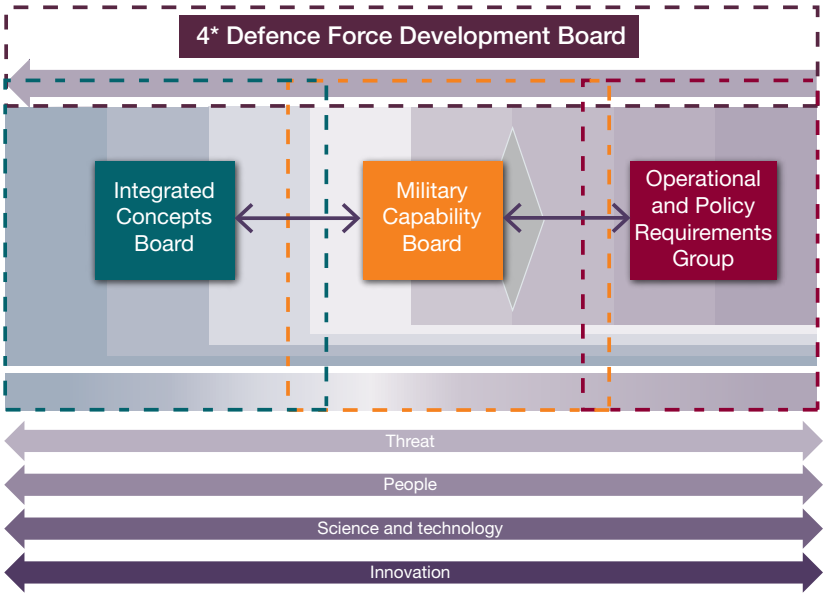
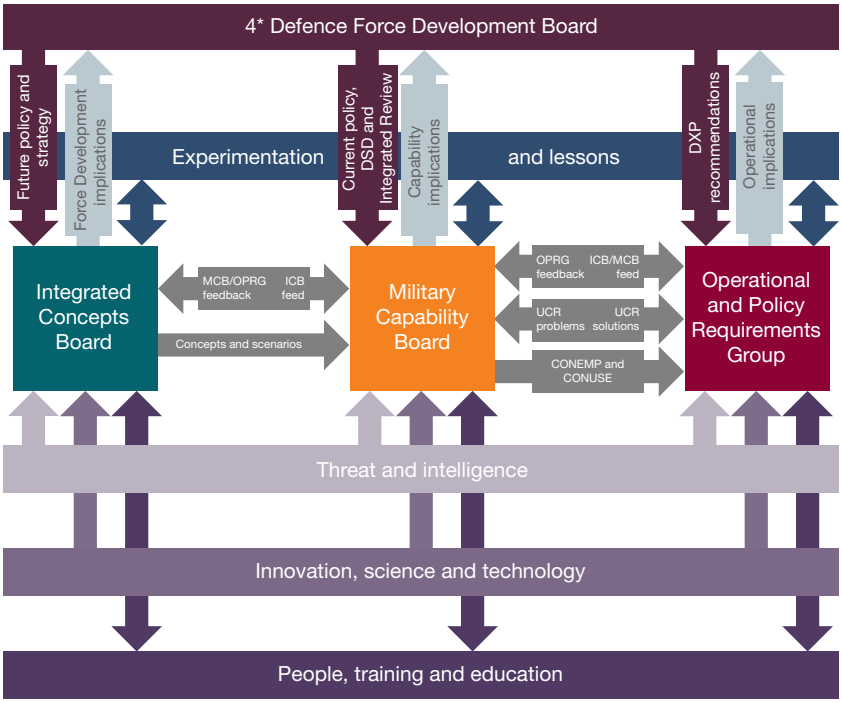


Figure 1.2 – Defence Force Development governance boards

1.6. **Top-level budget input.** DFD will enable close engagement with the top-level budgets and other organisations involved in designing and delivering forces and capability. Top-level budgets are key to the process; they must be empowered to experiment, innovate and respond

dynamically to changing threats and technologies, as well as informing Force Development. The DFD model enables delivery of the 'direct' function by Ministry of Defence (MOD) Head Office whilst ensuring the effective integration and coherence of top-level budget Force Development activity.

1.7. **Defence Force Development information.** Efficient information sharing at all levels is essential in the governance of DFD to enable informed, agile decision-making. Previous approaches to Force Development have been episodic and focused on epochs. The pace of change within the operating environment and rapid technology evolution, drives a requirement for the trajectory of Force Development to be able to adapt with agility, so that our Armed Forces have the capabilities to succeed. DFD is therefore an adaptive continuum that requires the right information to be available to inform decisions at the right time across all parts of the model. For example, lessons from operations and exercises can generate an urgent capability requirement (UCR), supported by experimentation that will in turn impact the development of our concepts and capabilities. Likewise, experimentation for concept and capability development may provide a gateway for innovation and technology acceleration that identifies capabilities that Defence can develop and integrate into the force. An efficient mechanism for information sharing is therefore essential to enable agile and informed decision-making, with consideration of upstream and downstream implications. To support agility and maintain momentum, an information management system will offer an 'all informed net'. Examples of the types of data and information flows are captured in Figure 1.3.



CONEMP	concept of employment	ICB	Integrated Concepts Board
CONUSE	concept of use	MCB	Military Capability Board
DFDB	Defence Force Development Board	OPRG	Operational and Policy Requirements Group
DSD	Defence Strategic Direction		
DXP	Defence Exercise Programme	UCR	urgent capability requirement

Figure 1.3 – An illustrative example of information flows across the Defence Force Development model

1.8. **Technology-led modernisation.** The MOD has adopted a 'technology-led modernisation' approach[2] that is integral to the DFD process, driving the adoption of cutting-edge technologies into service. Central to this approach is the Defence Technology Framework,[3] which identifies areas for technology development and adoption.

2 *Mobilising, Modernising & Transforming Defence: A report on the Modernising Defence Programme*, 2018.
3 *MOD Defence Technology Framework*, 9 September 2019.

1.9. **Innovation in Defence.** Experimentation provides evidence throughout and at any stage of concept, capability and warfare development on which innovation and technological developments offer the most promise. Defence conducts an increasing number of activities to design and develop innovative solutions driven by Defence innovation priorities,[4] which are intended to harness ideas and relationships from outside traditional boundaries. It seeks to change behaviours and to empower a culture where innovation is core to driving value. This will also help break down barriers which constrain our freedom to pursue and deliver innovative solutions, enabled through the Defence Innovation Fund and front line commands' innovation budgets.

Section 2 – Experimentation

1.10. **The imperative for experimentation.** The development of the DFD approach identified that while there was a significant amount of effort placed on Force Development itself, much of our capacity for experimentation focused on capability development and near-term adaptation rather than informing conceptual thinking to drive the agility required. This lack of a visible and coherent experimentation programme led to missed opportunities to coordinate across domains, exploit experimentation output and explore the potential alleviation of constraints. Addressing these challenges requires: visibility of Force Development requirements; a mechanism to balance experimentation resource and effort across the DFD functional areas; and evidence to support Force Development decisions.

1.11. **The role of experimentation.** Experimentation is described as the controlled and directed activities designed to discover new information about an idea or concept, test a hypothesis or validate a solution or choice. It sits at the core of the DFD process and is critical to building the evidence base that informs Force Development decisions in the following ways.

4 *Defence Innovation Priorities*, Defence Innovation Directorate, September 2019.

a. **Setting direction for decisions.** Assessing and exploring future challenges, bringing together insights from net assessment,[5] industry, academia, technology, innovation, and lessons from operations and exercises to inform policy and identify new ways of operating through strategic and operational concepts.

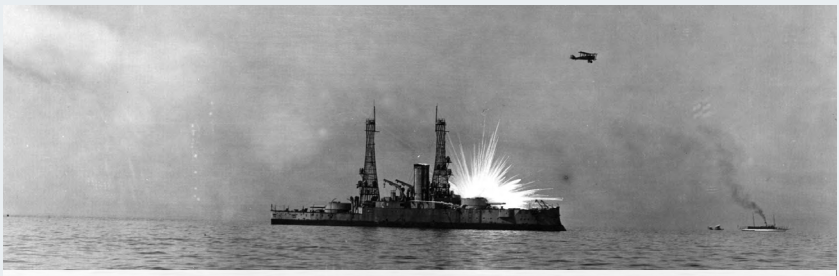
b. **Developing viable solutions.** Identifying and developing solutions to specific capability shortfalls/gaps or addressing and exploiting new disruptive opportunities into the Force Development programme. The starting point for this activity is Integrated Concepts Board-approved Defence operating concepts that are then explored through experimentation to derive the capability implications and inform requirements and, once matured, to be reflected in doctrine.

c. **Capability integration decisions.** Integrating capabilities and adapting the joint force to ensure that strategic tasks can be met. Experimentation activities will seek to provide near-term capability refinement/adaptation and identify solutions to emergent gaps; this includes experimentation on exercises and operational deployments.

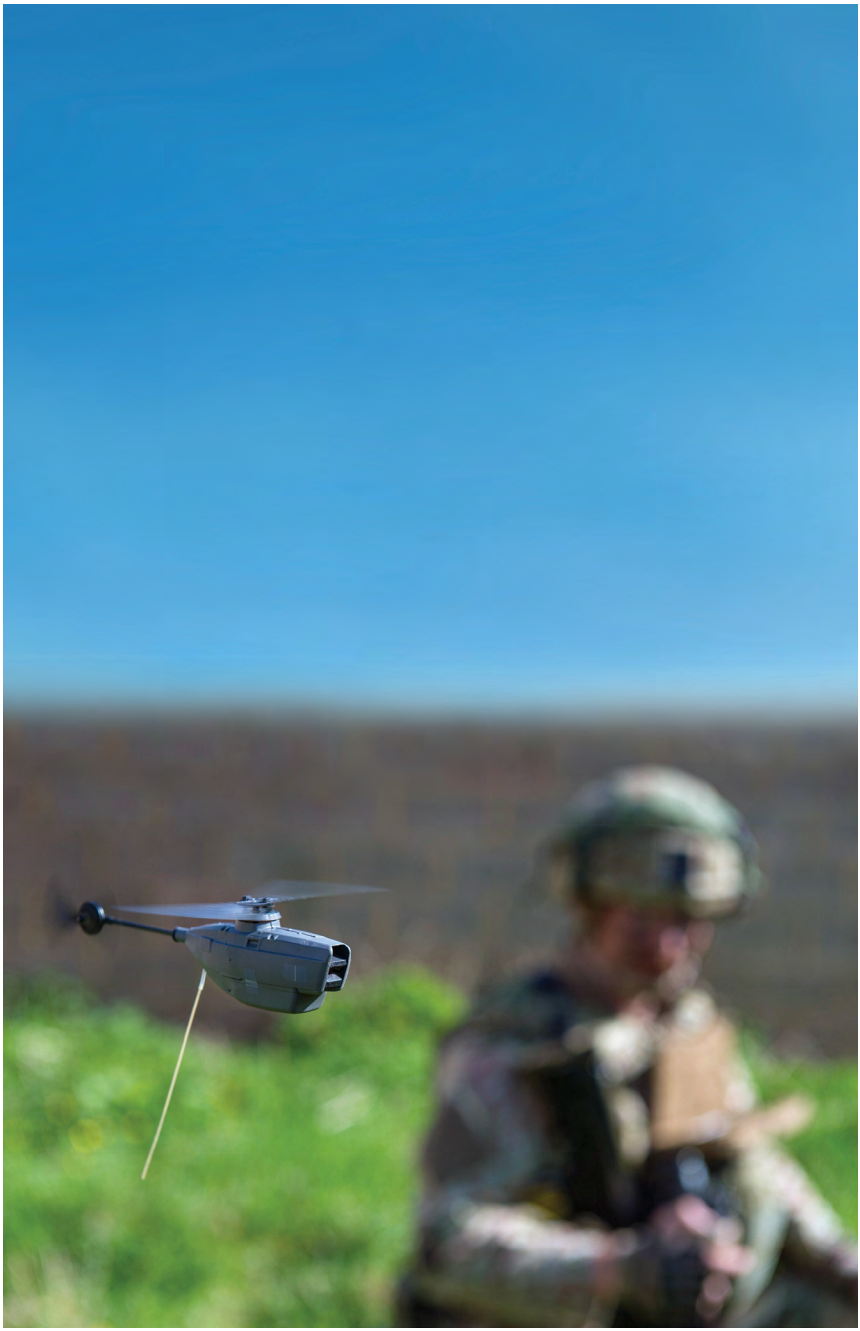
5 A process to assess the balance of strategic advantage between the UK (in the context of its alliances and partnerships) and major power competitors, by understanding what we are competing over, how the competition might escalate into conflict, and strengths and weaknesses of likely theories of success.

Example 1 of experimentation activities supporting Force Development: General Billy Mitchell – The ascendancy of air power over naval power

General Billy Mitchell led the United States (US) Army air units deployed to France in World War 1 from 1917. He advocated for air power, as the new domain, which had become decisive in influencing the maritime and land domains. He proposed investment into new aircraft carriers, rather than obsolete 'new' battleships, developing new aerial bombs and torpedoes and aircraft designs and new doctrine to create a strike capability against Imperial Japan – the major rival for dominance in the Pacific. In February 1921, he gained support from the US Navy and Army for a series of exercises, to test his theories. This anti-ship bombing exercise, known as 'Project B', with Mitchell's 1st Provisional Air Brigade, was equipped with various British and US aircraft and a range of bombs. From May 1921, when Mitchell assumed command, using experimentation and tactical evolution, bombing techniques were refined, payloads optimised, and skills improved. Combined with the design of large armour-piercing bombs, as well as incendiary and gas bombs, the unit rapidly gained in proficiency through training and refinement at the US Aberdeen proving grounds. In July 1921, Project B exercises saw the unit successfully sink the ex-German battleship SMS Ostfriesland, through a series of near misses, designed to fracture the hull. Further tests in September 1921 against obsolete pre-Dreadnought USS Alabama and in September 1923 against battleships USS Virginia and New Jersey, employed special 2,000lb bombs. This experimentation activity blended skills, pioneering techniques, knowledge and new technologies, demonstrating the validity of air power and the aircraft carrier, as being the decisive weapons of naval warfare in the looming World War 2.



USS Alabama being attacked in September 1921 by aircraft of the 1st Provisional Air Brigade



> At the heart of real change in military affairs is the notion of a 'learning organization', which is something quite different from a brilliant organization. This, in turn, requires an organizational culture that encourages experimentation and does not punish the failures that innovation invariably brings about.
>
> Eliot A. Cohen

Chapter 2

Defence Experimentation

Section 1 – Experimentation within Defence Force Development

2.1. **Experimentation within Defence Force Development.** Defence must ensure the capabilities it invests in are value for money prior to committing scarce resources on procurement. To achieve this, Force Development must be underpinned by experimentation to provide an important evidence base to enable informed decisions on validating concepts, developing capabilities or assessing urgent requirements. Defence has a long history of various experimentation activities, across all domains, which this handbook builds on. Generating new evidence in a coherent, efficient manner and drawing on diversity of thinking requires effective partnership with the science and technology, and innovation communities in Defence and in other government departments, academia and industry research and development sectors. Defence will share information about its Defence Force Development (DFD) priorities

and seek to exploit and integrate research and development through experimentation at the earliest appropriate stage. The challenges seen with conducting Defence Experimentation include:

- achieving a shared and agreed understanding of the problem, and the methods and techniques to be employed by those who sponsor/commission the experimentation;
- establishing mechanisms (including a management information system) to capture, understand and interrogate activity and outputs;
- developing effective methods to identify, prioritise and cohere activity; and
- availability of time, people and budgets.

Experimentation techniques

2.2. There are a variety of experimentation techniques that can be employed, noting that no single technique will provide the level of evidence, fidelity or insight that is required to address all questions. Different techniques and the different environments in which they are used suit different questions and address different facets of military capability (for example, modelling weapon effectiveness). In general, a number of techniques need to be combined within an experimental method to address specific capability-based questions. The strengths and weaknesses of some of the experimentation techniques that can be used are referred to in more detail in the Development, Concepts and Doctrine Centre's *Wargaming Handbook* and The Technical Cooperation Program's (TTCP) *Guide for Understanding and Implementing Defense Experimentation* (GUIDEx); a summary of a selection of techniques is provided at Annex B.

2.3. Experimentation needs to provide timely evidence to the decision-maker, with the experimentation method driven by time restraints, as well as the nature of the evidence required. However, the ideal experimentation method for addressing a specific DFD issue

or question may not always be achievable due to time, cost and other constraints. Achieving the necessary level of evidence, with sufficient fidelity within constraints, will need compromise in the method and generate assumptions that will need to be clearly stated when the evidence is presented. A framework for assessing the strength of evidence is set out at Annex C. Often capability-based experimentation activities will require a series of complementary activities within a method and, sometimes, multiple methods integrated into an overarching campaign are needed to address the complexity of a particular DFD issue by consolidating all the outputs. The precise form that an experiment takes will be driven by the requirements and objectives for the activity.

Defence Experimentation

2.4. Defence Experimentation can be used to: explore the veracity of ideas or concepts; test hypotheses; or assess the performance and/or effectiveness of changes to military capability. For DFD, Defence Experimentation[6] is defined as below.

> **Defence Experimentation (for Force Development)**
>
> Controlled and directed activities designed to discover new information about an idea or concept, test a hypothesis or validate a solution or choice in support of Force Development.
>
> (Defence Force Development Board, October 2019)

2.5. **Types of Defence Experimentation.** Defence Experimentation comprises three broad types (discovery, development and validation) that are inherently complementary (see Table 2.1) and applicable to all pillars of DFD (see Figure 2.1). Each type of Defence Experimentation will be in support of/supported by a range of methods and techniques.

6 All further references to 'experimentation' or 'Defence Experimentation' relate to experimentation for the purposes of Force Development only, and not wider experimentation activities (for example, in support of business process design or low-level scientific research).

Experiment stages during capability development to prototyping (Derived from TTCP GUIDEx)	Defence Force Development Defence Experiment types
Discovery. Intended to build understanding of a DFD issue and inform the development of potential solutions, which may be through all means available; for example, new concepts, alternative technologies, or developing alternative doctrine.	**Discovery.** Designed to build understanding, to inform the development of potential solutions, to introduce novel ideas, concepts and capabilities in the early stages and to help refine the question to be addressed. This type of experiment should be conducted against a broad hypothesis to ensure it has the freedom to explore but bounded for it to be achievable.
Refinement. Intended to support the maturation of an idea, concept or capability to where it can be assessed or validated as a potential solution to a given issue.	**Development.** Designed to assist in developing an idea, concept or capability, to mature it to a point where it can be validated. It is a refining process designed to test, at an early stage, whether the idea, concept or capability will deliver against its expectations.
Assessment. Intended to assess whether solutions are robust across a wide range of operational circumstances and generate the evidence needed for DFD decisions.	**Validation.** Designed to test, as far as practicable, the effectiveness of a given idea, concept or capability such that it may be considered viable enough to inform Force Development decisions.
Prototype refinement. Post-assessment decision development of a viable prototype such that the front line command understands the Defence lines of development changes needed to realise the new or improved capability.	
Prototype validation. To provide the final demonstrated evidence that the prototype capability (equipment) can operate within theatre and will achieve the required operational effectiveness.	

Table 2.1 – An evolution of Defence Force Development Defence Experimentation types

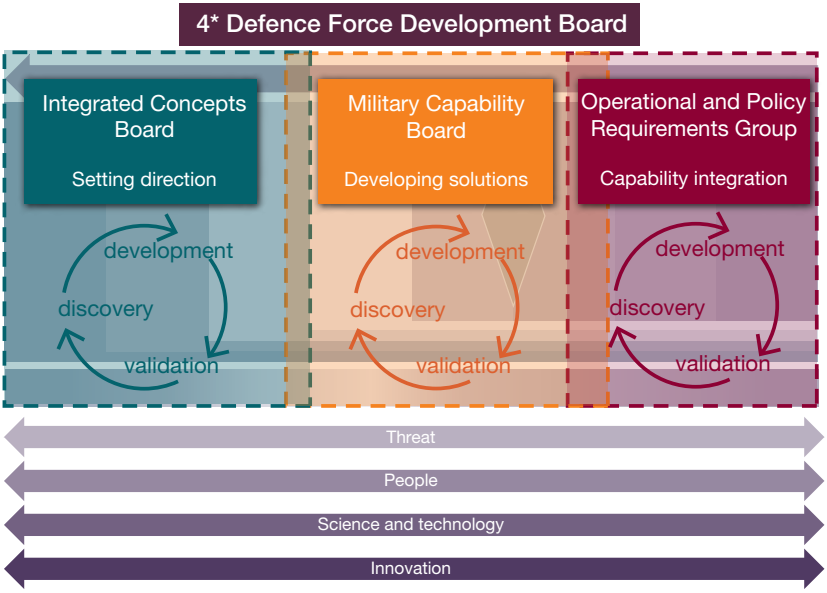


Figure 2.1 – Application of Defence Experimentation types across Defence Force Development

2.7. **Experimentation design principles.** Defence Experimentation activities should be designed to evidence decisions for DFD. This design, and associated planning, requires specialist skills but also relies on the problem owner/sponsor's identifying the issue. This will also include setting any constraints for the activity such as decision context, time frame, mission/task, theatre of operation(s), threat and resource. Successful experimentation is reliant on both the sponsor and designer developing a shared and accurate understanding of the issue under investigation. Sponsors of Defence Experimentation activities are recommended to focus on stating the issue causing concern and the nature of the decision to be supported. The following questions[7] illustrate the nature of the information needed to undertake successful

7 Chief Scientific Adviser guidance on the scientific method (and not question setting); these are factors in experimentation design and should not be perceived as to direct the method, choice of control, or metrics used.

Defence Experimentation design, with close collaboration between sponsor and designer.

- What is the issue/question? (Supports the development of the hypotheses to be tested and the treatments to be subject to experimentation.)
- Why is that a relevant question? (Clarifies the context in terms of the military capability gap or overmatch, the threat and/or operating environment.)
- How will you address the question? (Time and other resources constraints that will shape the techniques used.)
- Is there a comparison? (What baseline or control is to be used to test for any improvement in capability resulting from the treatments?)
- What will you count or measure? (The metrics that accurately reflect pertinent changes in performance and effectiveness resulting from the treatments.)
- How large a difference interests you? (What level of capability improvement is required?)

2.8. **Scientific staff support.** The Ministry of Defence (MOD) scientific adviser network embedded within the front line commands (FLCs) from Defence Science and Technology (DST) provide first-line support to experimentation. Additional support is available from DST, Defence Science and Technology Laboratory (Dstl), industry and academia, to ensure that military staff and sponsors/owners are in an informed position. This support can advise on experimentation methods, including using scenarios and vignettes, and provide a constructive challenge function. These scientific staff can also ensure the process for collecting and analysing evidence has access to supporting data that has been critiqued and assured.

2.9. **Experiment design components.** The sponsors/owners of experimentation requirements need to understand the five core components of an experiment for Force Development, as shown in Figure 2.2. This will help ensure the process is as effective as possible and the 'experimenters' are suitably supported. The five components are as follows.

a. **Treatment.** In scientific terms, the 'treatment' is also known as the independent variable.[8] It is the change in capability agreed with the sponsor that will be the subject of experimentation and could comprise: a new concept; alternative tactics, techniques and procedures; or a change in equipment. The treatment is linked to the aspect that the sponsor wants to examine and is intrinsically linked to the aims and objectives of the experiment. Treatments must be controlled during trials to avoid confounding the results, thereby being unable to identify the primary driver of change.

b. **Effect.** The 'effect' is the dependent variable,[9] the measured change that results from, or is associated with, the treatment, which is observable (by design) within the experimentation activity. The experiment needs to be designed in a way that effects can be created and ideally attributed to the use of the treatment.

c. **Experimental unit.** The 'experimental unit' is the military force (or wider Defence-related team) that uses the treatment-based capability in the context of the operation, mission and tasks. The design of the experimental unit is the outcome of a well-conducted stakeholder analysis between the sponsor and the experiment design team.

d. **Trial.** A 'trial' is one observation of the experimental unit using the modified or new capability (the treatment) within the experimentation activity. The data collected from the trial is tested to assess whether the treatment has an effect. Setting the experiment conditions and providing supporting tools, such

8 A causative variable that the experimenter intends to manipulate.
9 A variable that (it is hypothesised) will change as a result of manipulating an independent variable in an experiment.

as scenarios and vignettes, and models or simulations is vitally important as this influences the effects that are seen. The sponsor has a key role, in conjunction with the experimentation design team, in defining the operational context.

e. **Analysis.** The 'analysis' phase of experimentation activities compares the results of trials using the control or baseline to show whether the treatments have had an effect on capability.
It is critical that the analysis, during and post trial, is subsequently provided in a report and other exploitable formats to support decisions and follow-on activity within DFD.

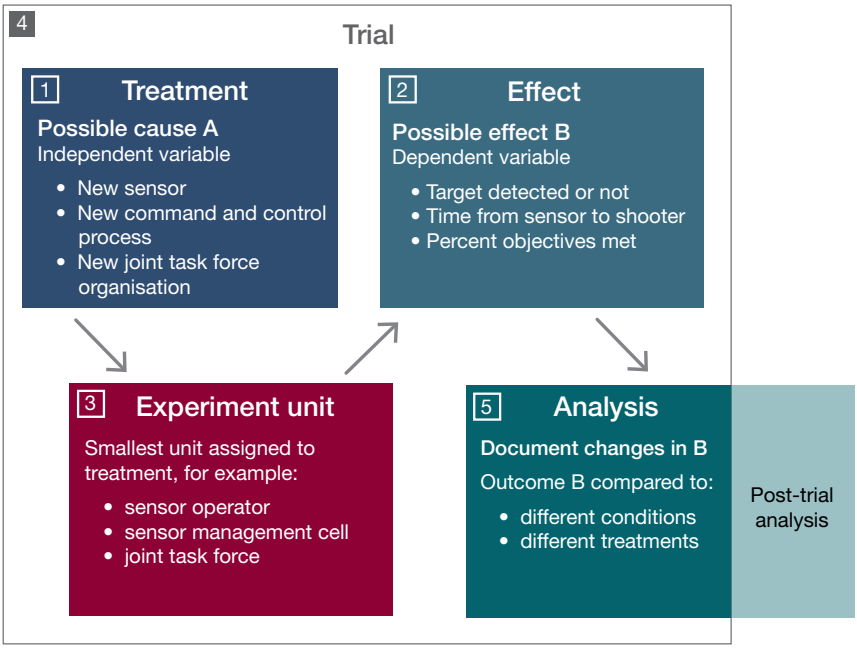


Figure 2.2 – The five core components of experiment design

2.10. **Assurance.** A robust assurance mechanism ensures appropriate quality of evidence and that Defence Experimentation outcomes have followed the correct governance processes and match the priorities set by the DFD Board (DFDB). Such assurance will ensure that experimental activity addresses the right question (the issue and not the symptom) and is the right activity (namely, it reflects the key elements of the capability in question with appropriate rigour). To be truly credible and valid, assurance mechanisms should be assessed by peer review and assessed by the sponsor prior to tasking the activity supplier to ensure that the experimentation question/issues are afforded the appropriate priority.

2.11. **Lessons.** Lessons from operations and exercises, as managed through the Defence lessons process, may contribute to setting the experimentation requirement and to subsequent Force Development.[10] However, the evidence from experimentation (for example, findings and insights) are not input to the Defence lessons process as a matter of course and should not be referred to as 'lessons' in that sense. Occasionally, the evidence from experimentation activity may have implications for current practice and capabilities as a by-product; such evidence may be passed to the Defence lessons process for treatment as a lesson.

2.12. **Levels of Defence Experimentation activity.** To enable effective governance, it is necessary to categorise experimentation activity by the level of the sponsor, where the requirements are set, and where the outcomes will be used. A three-level framework is used to categorise Defence Experimentation activity, although the levels do not indicate priority; examples are shown in Table 2.2.

10 Joint Warfare Development Board, as highlighted in Table 3.1.

	Level 1	Level 2	Level 3
Description	Single-Service organisation	Joint and integrated	Defence
Example Defence Experimentation activity	The Royal Navy and Royal Marines experimentation on an **autonomous advance force** aimed to integrate autonomous systems in the littoral environment designed to meet the needs of the Future Commando Force and Littoral Strike capability.	**Exercise Joint Venture** is a command post exercise for the 2* Standing Joint Force Headquarters (SJFHQ) with components. It provides a platform to rehearse elements of the 2* SJFHQ developing and rehearsing concepts, and assures SJFHQ in its ability to deliver the military contribution to Fusion Doctrine.	**Exercise Cyber Warrior** is a national exercise conducted with cross-government and Five Eyes partners to test a range of capabilities being developed. It provides a collective training opportunity for Defence's cyber units' testing capabilities and integration with conventional Defence forces and partners.
	Exercise Agile Warrior is the British Army's examination of current and emerging threats and opportunities for land capability. It generates an evidence base to inform the continual transformation of land forces and force structures across all Defence lines of development.	**Exercise Joint Warrior** is a UK live exercise to provide collective training objectives for the commander task group level down to the unit level. Training is focused on preparing tactical formations operating below the combined/joint force component level for operational employment.	United States **Schriever Space Wargame** focuses on ten-year horizon to identify future force planning and systems integration requirements, played at the strategic to joint operational level, to examine space concepts and doctrin1e practices. It tests structures, processes and procedures and considers future capabilities and concepts.
	Exercise Eagle Warrior is the Royal Air Force's experimentation campaign, which investigates a number of aspects of major warfighting across multiple time frames. Black Eagle events investigate the effects of highly classified capabilities on warfighting operations in tightly controlled but joint environments.		North Atlantic Treaty Organization (NATO) **Joint Military Operations in an Urban Environment** experiment explored joint urban operations to gain an understanding of the multidimensional urban operating environment, with consideration to urban-social resilience and sustainment of urban operations including novel resupply methods.

Table 2.2 – Examples of Defence Experimentation activities and levels

2.14. **Defence Experimentation environments.** Defence Experimentation is conducted in one or more representative environments, or blends of these.[11] Each environment has different characteristics, as shown in Table 2.3, which favour different facets of military capability. As with the different experimentation techniques, these characteristics must be considered when designing the activities needed to address the DFD question. MOD science advisers and Dstl scientific staff can provide advice on the most appropriate simulation(s) available for experimentation.

Defence Experimentation environment	Characteristics	
Real operations	Real people Real environment Real equipment Real weapon effects	Conducted on real operations or through empirical analysis of real operations.
Live simulation	Real people Real environment Real equipment Simulated weapon effects	Where real people are used in a simulated situation.
Virtual simulation	Real people Simulated environment Simulated equipment Simulated weapon effects	Realistic computer-generated environments that allow natural human-system interaction.
Constructive simulation	Simulated people Simulated environment Simulated equipment Simulated weapon effects	Those that simulate the operating environment but in which no human intervention occurs.
Temporal		Knowledge and experience applied through judgement and opinion.

Table 2.3 – A summary of Defence Experimentation environments

11 Military training systems are created from blending live and constructive simulations or virtual and constructive simulations.

2.15. **Experimentation activities.** With experimentation activities being conducted concurrently at the Defence, joint and single-Service organisational levels, as shown in Table 2.2, there is a need to generate a common picture to ensure best use of resource, to maximise opportunities and exploit progress. Experimentation requirements and activities need to be captured and understood to ensure coherence and conducted to serve a specific purpose or respond to questions. The specific purpose is determined by the experimentation owner/sponsor and should be aligned with the priorities set by the DFDB. Defence Experimentation activities will require cooperation and communication with a broad array of stakeholders and partners.

2.16. **Experimentation within exercises.** Training exercises can have a very powerful role in providing comparative data (such as baseline data that characterises current performance) for subsequent experimentation activities. Defence 'exercises' for both training and experimentation purposes share similar design principles, albeit experimentation activities are normally bespoke and not repeated for ethical and resource efficiency reasons. Although training events can be used to support bespoke excursions for Defence Experimentation purposes, the requirement to achieve current time frame collective training objectives can conflict with the requirement to test hypotheses that are grounded in a different 'future'. Further, Defence Experimentation requires participants to be trained so they are competent in the way of operating required by the treatment; this can (frequently) be burdensome and impact on the original training intent. Nevertheless, some experimentation can be carried out within training events if extreme care is carried out in both design and execution. Cost and other resource efficiencies can be gained from repeating the training scenario and reusing existing training infrastructure and teams.

Section 2 – Defence Experimentation activities for Defence Force Development

Planned force testing

2.17. Planned force testing (PFT) tests the ability of the planned force structure to deliver the policy outcomes of departmental reviews and provide a policy-compliant, resource-informed evidence base to support capability development and force design. The planned force structure is tested against endorsed Defence scenarios across the range of: Defence Planning Assumptions; operation types and environments; and threats and challenges. This testing provides an evidence base to support: annual capability audits; Defence Capability Assessment Register and planning/budgeting processes; and Investment Approvals Committee business cases and acquisition processes. PFT will be shaped by Defence challenges and changes to Defence Planning Assumptions. PFT is an understand/baselining activity of testing a force against policy, rather than truly being an experimentation activity. The insights derived from PFT will inform other experimentation activity.

planned force testing

Testing of the current planned force against a series of policy compliant scenarios which represent current Defence Planning Assumptions (including concurrency), to provide an evidence base to support capability and Force Development.

(derived from *MOD Finance Military Capability Strategic Force Development*, November 2015)

2.18. PFT planning events are conducted by formed operational or tactical headquarters (or bespoke planning teams), augmented by experts and other government departments. The campaign plans developed are then tested using wargaming and campaign modelling. PFT explores individual scenarios and operation types; different combinations of campaign plans and operation types that are subject to concurrency analysis to determine whether the planned force is capable of meeting

Defence Planning Assumptions. This will help identify potential shortfalls or excesses, as well as risks within the force structure. Testing will also develop alternative courses of action and consider additional vignettes. Variations to examine alternative capability risks and identify potential solutions may be considered in subsequent force variation testing.

Force variation testing

2.19. Force variation testing uses PFT as a baseline along with potential solutions and ideas from force exploration or other sources to identify how policy aspirations, capability shortfalls, financial issues or Defence challenges could be addressed. The evidence acquired will feed into force design in preparation for any future departmental reviews. Force variation testing seeks to vary a factor within PFT to provide evidence that specific capabilities or concepts provide operational advantage to the future force.

force variation testing

Testing variations of the planned force baseline to provide evidence of the efficacy of specific capabilities, concepts or policy changes to achieve operational advantage to the future force.

(*Strategic Force Development Committee and Working Group Terms of Reference*, 6 May 2020)

2.20. Force variation testing uses campaign plans (aligned to policy but not rigidly constrained by them) developed in PFT and considers what difference force variations from force exploration would have on campaign outcomes compared to the planned force. Those solutions judged to have sufficient merit can be taken forward into Departmental reviews, lead to directing further science and technology research, or receive innovation funding.

Force exploration

2.21. Defence needs to look to the future and consider how it could deal with a broad range of risks and threats, as well as opportunities, it might encounter. Other experimentation activities, net assessments and Defence challenges will identify a range of risks and threats to which conventional or current capabilities and ways of operating offer no real solutions. Force exploration demands unconstrained, innovative thinking that goes beyond military thinking; academia, industry, allies and partners will all have an essential role to play. Solutions will be sought from a variety of sources, such as emerging policy, concepts, technology and innovative ideas. Solutions may entail adopting new technologies, applying novel ways of operating current and new capabilities or alternative approaches to operating. Force exploration must not be constrained by current policy, strategy, capabilities or legal aspects. Instead it should investigate the implications of such constraints to support their evolution in the future.

force exploration

The application of innovative thinking to the use of current, emerging and disruptive technology, innovative ideas, and novel ways of operating to understand how they may be employed on operations or in delivering Defence business, together with an assessment of feasibility.

(derived from *MOD Finance Military Capability Strategic Force Development*, November 2015)

Section 3 – Defence Experimentation Campaign

Understanding the Defence Experimentation landscape

2.22. The ability to visualise experimentation requirements on a capability basis (including questions) and a timetable of events will be essential – particularly to prioritise and resource critical activity. The

Defence Experimentation Campaign allows experimentation activity to be categorised by level and the principal element within the DFD model that it supports, as well as synchronising requirements and activities to maximise opportunities and prevent duplication of effort. A Defence Experimentation Campaign Plan (DECP) provides a visual representation of Defence Experimentation activities across time and will aid synchronisation of planned activities and outcomes. Figure 2.3 depicts an illustrative representation of Defence Experimentation requirements and activities by level and the principal element within the DFD model they support.

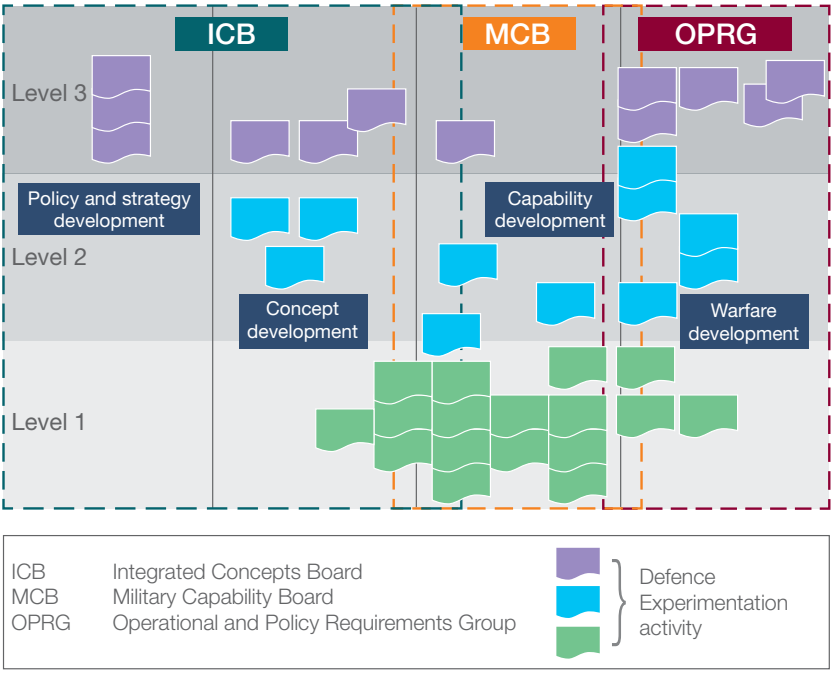


Figure 2.3 – An illustrative example of a Defence Experimentation Campaign Plan

2.23. The DFDB directs its priority challenges (albeit other non-priority challenges exist and can also be addressed by top-level budget experimentation). These challenges are cross-checked against the existing evidence to understand where the evidence to support Force Development decisions is lacking. Those areas lacking evidence will be designated Defence Experimentation priorities and mapped against extant activity to understand gaps in experimentation activity. The DFDB directs Defence Experimentation priorities drawn from the Defence Plan to overcome these gaps. The DFD model will need to adapt to unforeseen challenges and re-prioritise accordingly, with comprehensive feedback and feed-across mechanisms to ensure the full exploitation of the evidence. Vice Chief of the Defence Staff, through the DFDB, exercises overall responsibility for setting Defence-level priorities for experimentation.

Defence Experimentation Pathway

2.24. Experimentation sits at the core of the DFD process and is critical to building the evidence base that informs DFD decisions (including supporting investment and capability decisions associated with the Joint Requirements Oversight Committee and Investment Appraisals Committee.[12] Experimentation activity underway across Defence requires a mechanism to provide visibility and understanding, ensuring coherence with DFD priorities and avoiding duplication. Activities that do not align with DFD priorities are at greater risk of being conducted in 'stovepipes', duplicating effort elsewhere and are less able to provide insights that support evidence-based decision-making. As such, they are likely to focus on investigating 'what is possible' rather than 'what is required'. The Defence Experimentation Pathway (DEP) is the mechanism to capture, support and cohere experimentation activity.[13]

12 Joint Service Publication (JSP) 655, *Defence Investment Approvals*, April 2020, provides further details on the application of the investment approvals process in the Ministry of Defence.

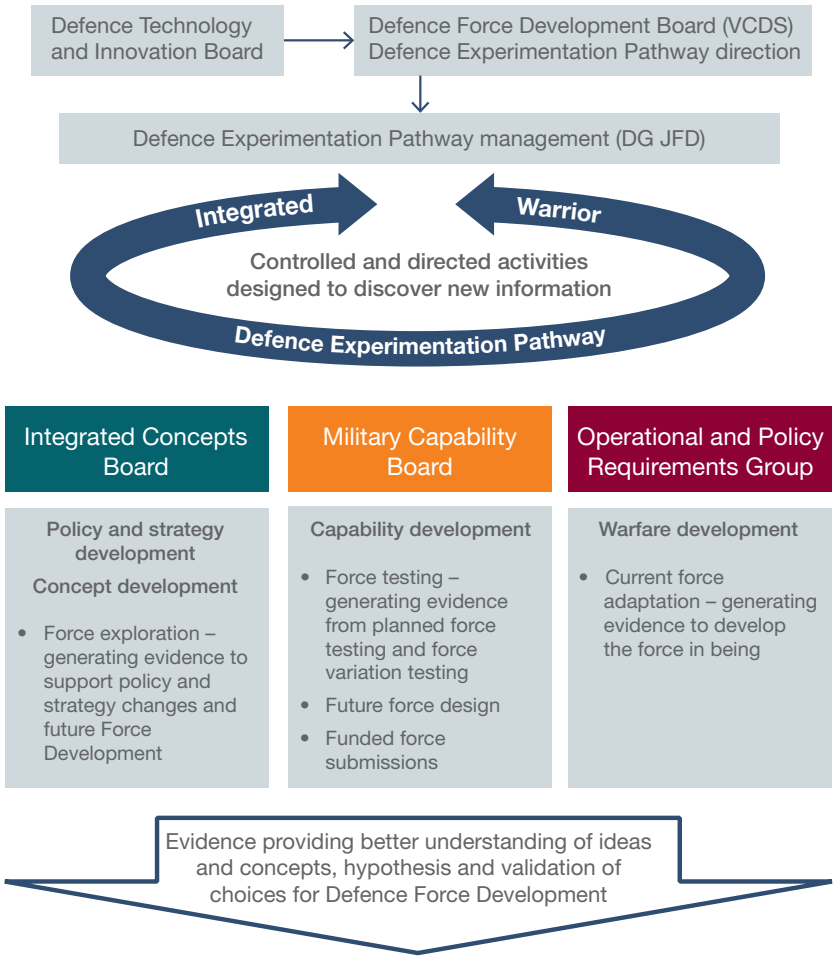
13 Defence Experimentation priorities are agreed by the Defence Force Development Board (DFDB) and articulated in the Defence Plan.

Defence Experimentation Pathway

The mechanism to capture, support and cohere Defence Experimentation activity connected to prioritised Defence Force Development activity.

2.25. The DEP will allow Force Development to undertake concept-to-capability development as quickly as possible, encompassing all aspects of Defence Experimentation across the spectrum of concept, capability and warfare development. The DEP is the mechanism, as shown in Figure 2.4, to provide evidence to the DFDB, and its subordinate boards. The DEP comprises four elements seeking to:

- establish the purpose of experimentation activity;
- capture and coordinate Force Development experimentation and requirements;
- identify those experimentation activities that need to be cohered and articulated within the Defence Plan; and
- achieve coherence of activities, whilst ensuring that latitude remains for dynamism and adaptation through learning from experimentation.



DG JFD	Director General Joint Force Development
VCDS	Vice Chief of the Defence Staff

Figure 2.4 – Defence Experimentation Pathway

2.26. **Defence Experimentation Pathway outcomes.** The principal intended outcomes derived from the DEP and its focus on efficiency and cooperation are as follows.

- Identifying and articulating Defence Experimentation priorities.
- The ability to adopt a coherent, 'campaign' approach to experimentation, including the efficient alignment of resources to activities and priorities and measuring progress.
- Establishing a single repository for all Defence Experimentation activity, enabling improved situational awareness and data-sharing across all stakeholders.
- Providing a single Defence Experimentation forum and portal for cross-pollination of Defence, government, and industry and academia innovation, experimentation, research and development – thus increasing efficiency and effectiveness of MOD research and development and DFD programmes.

2.27. **Integrated Warrior.** Integrated Warrior is the external facing brand of the longer-term aspects of Defence Experimentation to link industry and academia with the DEP to identify: shared interests; research and development; innovation programmes; and/or opportunities to exploit emerging thinking through cooperation/collaboration. With the inclusion of industry and academia, a whole force enterprise approach is ensured to best meet the experimentation priorities set by the DFDB. This will generate and collate evidence to inform future strategies, concepts, force design, capability development and, ultimately, balance of investment decisions.

Example 2 of experimentation activities supporting Force Development: The inter-war reorganisation and force development innovations of the Weimer Republic Reichswehr between 1920-1933

The post-World War 1 German Army, or Reichswehr was constrained by the 1919 Treaty of Versailles to 100,000 men, its general staff was disestablished, and Germany was not allowed tanks, heavy artillery, armoured cars, or aircraft. The Reichswehr Commander, General Von-Seeckt formulated an intellectual framework to exploit new ideas, theories, lessons and new technologies, to offset numerical weakness, which emphasised mobility and aggressive offensive operations.

As the defeated army in World War 1, experimentation, force exploration development and identifying technological advances was critical; the old military order was swept aside, understanding the reasons behind Germany's defeat was paramount. Von-Seeckt, initiated a comprehensive lessons-learned process, including analysing tactical and operational failures and successes, as well as looking closely at the coordination of the Allied summer offensive of 1918, the so called '100 days' and the Allied innovations, that ensured its victory. The Reichswehr gathered as much information on post-war 'emerging' Allied theory, including the proposed Allied 'plan 1919', the first all arms integrated strategic offensive plan, devised by the British military theorist JFC Fuller, as well as emerging theories on future tank warfare. The Reichswehr created a four-stage programme to build capabilities.

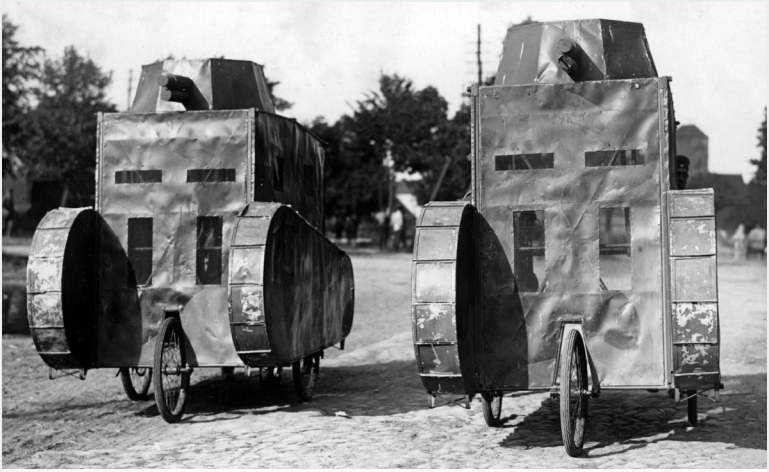
Firstly, selecting only the best candidates from the former Imperial German Army to make up the 100,000 interwar Army, the best staff officer qualified and combat-experienced candidates, forming the officer corps nucleus of an Army that could be rapidly expanded.

Secondly, a clandestine foreign weapons and technology development/ acquisition programme to invest in arms manufacturing companies in Holland, Sweden and Switzerland. Weapons, artillery, tanks, torpedo boats, U-Boats, fighter aircraft, munitions/armaments and radio communications were designed and perfected outside the Versailles Treaty restrictions.

Thirdly, an innovative training and education programme that maximised theoretical and doctrinal refinement, coupled with field training exercises, experimentation and war games. Foreign observers were dismissive; the media openly contemptuous of these efforts which were low cost and could be repeated many times, allowing integrated concepts of mechanised warfare to be practised and commanders to experiment and critique.

Fourthly, a military exchange and training programme (1922-1933), between Germany and the Soviet Union; perceived as 'pariah' states and sharing a joint incentive to rebuild capabilities. Large training areas inside Russia allowed experimentation of new tactics, weapons, theories and technologies; such as enhanced gas warfare.

This experimental approach was fundamental to the evolution of Germany interwar military theory, that would develop into the 'revolutionary' 'Blitzkrieg' concept.



Facsimile tanks on bicycle and canvas frames employed by the German Reichswehr on field manoeuvres 1925

Notes

© Courtesy BAe Systems

> The practice of war itself can provide military organizations with a strong incentive to learn from their experiences and to test different technologies. Indeed, the possibility of failure provides a powerful motivation for military organizations to innovate and adopt new technologies as a means of turning the tides of battle.
>
> Adam M. Jungdahl and Julia M. Macdonald

Chapter 3

Orchestrating the Defence Experimentation Pathway

Section 1 – Governance for Defence Experimentation

3.1. **Governance.** Vice Chief of the Defence Staff exercises overall responsibility for setting Defence priorities for Force Development experimentation through the Defence Force Development Board (DFDB) and the Defence Plan; the responsibility for coherence rests within Joint Force Development (JFD). The Defence Experimentation Working Group (DEWG) and JFD Headquarters J7 staff develop and propose Defence Experimentation priorities to cohere the requirements of all pillars of Defence Force Development (DFD) including Force Development activities conducted by the Ministry of Defence's (MOD's) science and technology, and innovation communities and front line commands (FLCs). The DFDB formally adopts and articulates priorities and critical information requirements that support the development of policy, strategy, concepts and capability.

3.2. **Boards.** The underlying idea for the governance of Defence Experimentation is that no additional boards should be required. The need to govern Defence Experimentation activity must be a standing agenda item within each of the principal DFD boards. The roles and responsibilities of the DFD governance boards are summarised in Table 3.1.

Board/ organisation	Roles and responsibility
Defence Force Development Board	Sets experimentation priorities. Owns and approves the Defence Experimentation Campaign Plan (DECP) and directs experimentation priorities in the Defence Plan.
Defence Technology and Innovation Board	Responsible for science and technology, and innovation activities, including technology development, demonstration and experimentation.
Integrated Concepts Board	Responsible for Defence Experimentation priorities and coherence within the policy and strategy, and concept development areas – with a priority on setting force exploration responsibilities. The Integrated Concepts Board ensures Force Development is concept-led (evidence-based) and thus enables concepts to be scrutinised and approved by the Integrated Concepts Board prior to Military Capability Board review.
Military Capability Board	Responsible for experimentation activities within capability development. The Military Capability Board has specific responsibility for conducting planned force testing and force variation testing.
Operational and Policy Requirements Group	Responsible for experimentation priorities and activities within the generate and operate areas. The Operational and Policy Requirements Group (OPRG) identifies short-term policy, capability, doctrine and concept gaps through the MOD's Strategic Frameworks, bridging the gap between urgent capability requirements and longer-term Force Development. These shortfalls are presented to the DFDB through the Integrated Concepts Board and Military Capability Board to shape experimentation priorities and activities. The OPRG is essential to baselining the requirement for change, particularly through lessons and doctrine.

Board/ organisation	Roles and responsibility
Strategic Command	Responsible for derivation of joint experimentation plans and for the overall coherence of the DECP.
Joint Warfare Development Board	Informs the DFD process on lessons-based warfare development experimentation requirements.
Front line commands	Responsible for the derivation of domain experimentation plans in line with DFD priorities.

Table 3.1 – Defence Experimentation governance and responsibilities

Enabling coherence and coordination

3.4. The principal DFD (3*-level chaired) boards provide governance vertically, with coherence provided by the DFDB, supported by DFDB secretariat staff. Horizontal coherence of the Defence Experimentation Pathway, and the means to share experimentation information and measure/report progress, is delivered through the DECP. Director General JFD is responsible for this coherence, which is fulfilled by JFD Headquarters J7 staff and the DEWG through the following functions, and as shown in Figure 3.1.

- Direct – the DFD-level challenges.
- Understand – the existing evidence available to support decisions against these challenges.
- Prioritise – evidence-gathering requirements against evidence gaps.
- Understand – the extent of extant experimentation activity.
- Direct – the priorities for DFD experimentation, either to initiate or ensure the continuation of activity.

- Assure – that experimentation activity and results are matched to the priorities and requirements.
- Exploit – the results of experimentation activity widely through full feedback and feed-across DFD working groups and boards.
- Adapt – to unforeseen challenges and re-prioritise accordingly.

Figure 3.1 – Cohering Defence Experimentation

3.5. Coherence of Defence Experimentation is achieved through capturing experimentation information. This information includes:

- experimentation requirements (what needs to be done);
- experimentation activities (what is being done); and
- evidence from previous experiments (what has been done).

3.6. To provide situational awareness, coordination and support governance mechanisms, Defence Experimentation requires the following functions:

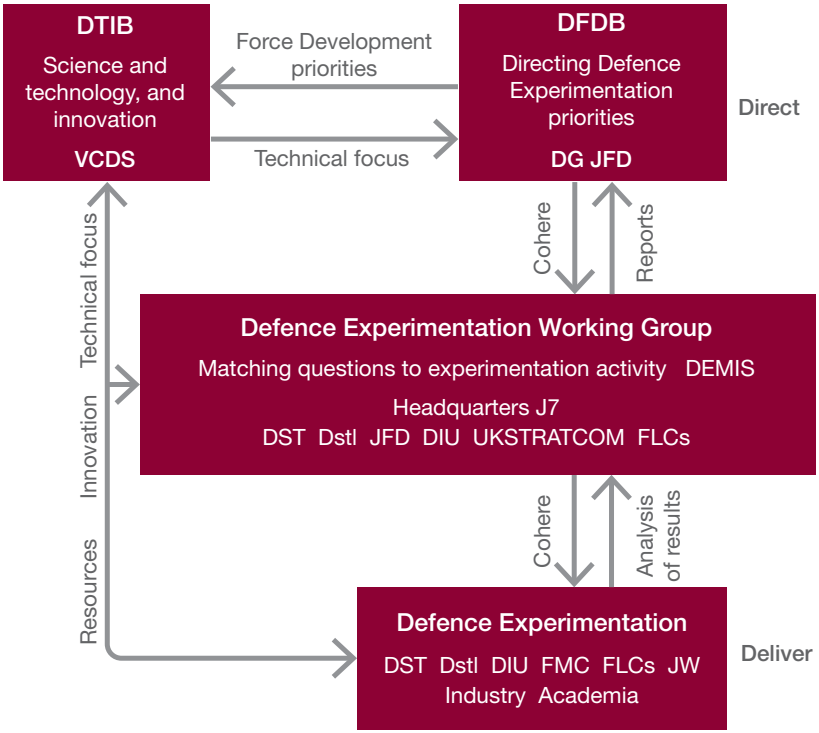
- coordination of Defence Experimentation requirements for input into the DECP;
- management of the Defence Experimentation Management Information System (DEMIS); and
- assurance that Defence Experimentation activity informs DFD.

Defence Experimentation Working Group

3.7. The DEWG provides the coordination function of the Defence Experimentation Pathway and is chaired (at 1* level) by JFD Head J7, with secretariat support from JFD Headquarters J7 staff. The DEWG includes representatives from FLCs, Strategic Command, Defence Science and Technology, Defence Science and Technology Laboratory (Dstl), Defence Innovation Unit and the 3*-level DFD boards. It is the principal Defence Experimentation working-level mechanism for interaction with the MOD's science and technology, and innovation communities (beyond the practical level of experimentation occurring within and across FLCs). The DEWG is accountable to the DFDB via Director General JFD, reporting as shown in Figure 3.2. The DEWG's responsibilities include:

- identifying opportunities for synergies between experimentation aims and objectives to meet multiple requirements across the DFD model;

- managing the DEMIS;
- cohering and coordinating Defence Experimentation on priorities set by the DFDB;
- synchronising and/or integrating Defence Experimentation activities with the objectives of the Defence Technology and Innovation Board (DTIB) and Defence Innovation; and
- providing reports to inform DFD governance boards, including recommendations for Vice Chief of the Defence Staff/DFDB prioritisation of the Defence Plan.



DEMIS	Defence Experimentation Management Information System
DFDB	Defence Force Development Board
DG JFD	Director General Joint Force Development
DIU	Defence Innovation Unit
DST	Defence Science and Technology
Dstl	Defence Science and Technology Laboratory
DTIB	Defence Technology and Innovation Board
FLC	front line command
FMC	Finance Military Capability
JFD	Joint Force Development
JW	Joint Warfare
UKSTRATCOM	Strategic Command
VCDS	Vice Chief of the Defence Staff

Figure 3.2 – Defence Experimentation Pathway process map

Planning activity

3.8. Data collection and sharing enables planning and cohesion by the DEWG; each lead organisation is ascribed Defence Experimentation priority areas. Contributing organisations (top-level budgets, higher-level budgets or enabling organisations as appropriate) should assign leads to these priorities – either through using extant planning functions, such as capability planning groups, or establishing a dedicated new experimental planning group if required. The DEWG and JFD Headquarters J7 staff will work with the priority leads to de-conflict resources and share data across thematic areas. Exposure of various plans will aid synchronisation of evidence gathering and resourcing, in turn supporting improved coordination and greater cohesion, avoiding duplication of effort.

3.9. **Ethical considerations.** Most Defence Experimentation will involve human participants. Although these participants are unlikely to be the direct subject of the experimentation, MOD rules on ethical research must be adhered to whilst planning and executing experimentation activities. In some circumstances, explicit approval from the MOD Research Ethics Committee[14] may be required.

3.10. **Links to science and technology, and innovation.** The DTIB ensures a strategic perspective on science and technology, and innovation issues, independent of immediate equipment plan challenges. The DTIB sets the level of ambition and priorities for technology development, adoption and innovation, identifying potential areas of capability opportunities and solutions to explore. The DTIB supports the DFDB by ensuring that science and technology, and innovation activities are organised and tasked to support DFD processes. The DTIB monitors and coheres Defence innovation and science and technology activities via initiatives such as the 'Technology and Experimentation Plans'.

3.11. **Innovation Delivery Group.** The Innovation Delivery Group is an advisory group whose role is to provide recommendations and challenge to the DFDB on potential game-changer capabilities and their effective and sustainable delivery. It will draw on the extensive expertise of the

14 Joint Service Publication 536, *Governance of Research Involving Human Participants*.

Defence Innovation Advisory Panel – a group of external innovation and business experts answering to the Secretary of State for Defence – to advise on what can be achieved through innovative practices beyond the Department's current ways of working.

3.12. **Relationship with industry and academia.** Director Defence Innovation is responsible for the Defence and Security Accelerator, which funds exploitable innovation to support UK Defence and security quickly and effectively, whilst engendering UK prosperity. Director Defence Innovation and Director Science and Technology respectively co-chair working groups in the Defence Suppliers Forum (such as the Research, Technology and Innovation Group) which is the MOD's primary means of consulting with the Defence industry. The DEWG will identify and recommend opportunities, with experimentation owners, for industry participation in experimentation activities at all stages of DFD, as illustrated in Figure 3.3. Where appropriate, the DEWG will invite industry (organisations and forums) to participate in key experimentation events, based on the endorsed Defence Experimentation priorities. The DEWG and sponsors/owners of experimentation activities will need to consider the contractual implications for inviting industry and academia.

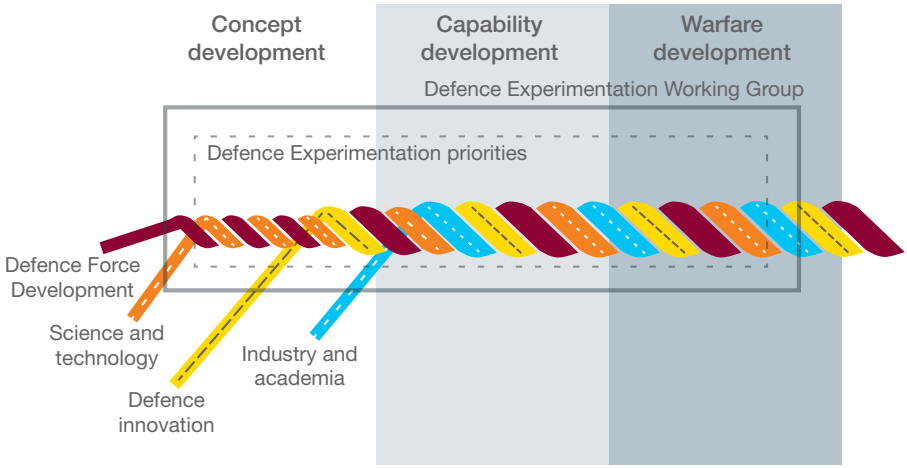


Figure 3.3 – Partnering in Defence Experimentation

Section 2 – Managing Defence Experimentation

3.13. The Defence Plan encapsulates the DFDB's direction on Defence Experimentation priorities. Defence Experimentation priorities are to be derived from analysis across all pillars of DFD and refined by the DEWG. Within the DEWG, science and technology expertise and DFD staff combine to generate high-level hypotheses, priority questions to enable development and assessment through experimentation. A pathway for each priority area is developed by matching experimentation activities and resources to address the key question set.

Recording and tracking experimentation

3.14. A specific and dedicated DEMIS is essential to deliver assurance, prioritisation and coherence. The DEMIS is a process-enabling tool; its information is shared across the whole of DFD. The DEMIS is accessible to the Defence Experimentation community to ensure experimentation metadata is captured at an appropriate classification. The information will aid campaign management, exploitation, information sharing, risk articulation and management, report generation and links to existing FLC and Defence capability management tools. The DEMIS will be revised accordingly to add further applications and services, with a focus on automating the input of data.

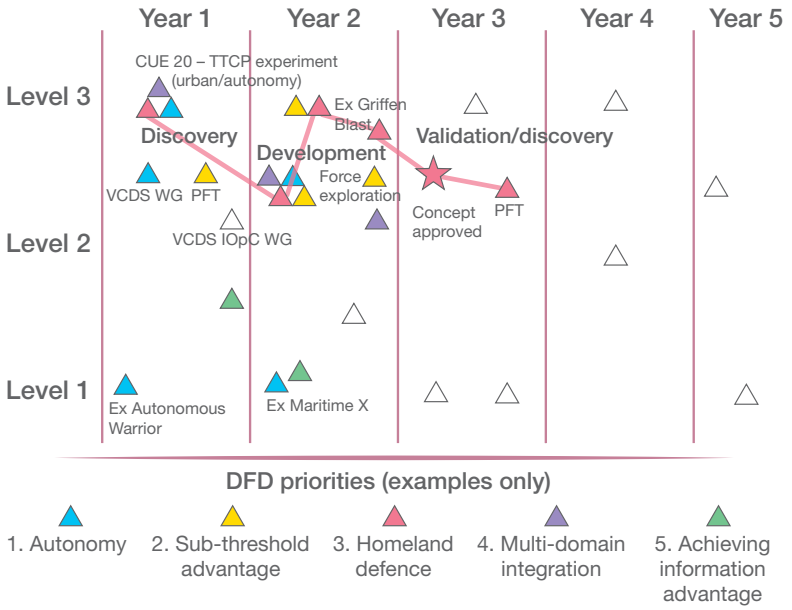
3.15. The DEMIS records Defence Experimentation activities for Force Development. Records will show the relationships between individual experiments and how they relate to the Defence priority questions and experimentation priorities set by the DFDB. They will also show the resources required/allocated, agencies involved in each experimentation activity, how they are to be delivered and by when. Although the DEMIS will be available to all DFD stakeholders, its development and maintenance will be held by a combination of JFD Headquarters J7 and DEWG staff. A guide to the DEMIS with the input of legacy and new experimentation activity/data is available as a separate document that sits alongside this publication.

Defence Experimentation Campaign Plan

3.16. The DECP supports the management and coordination of Defence Experimentation for DFD, which is synchronised with Defence and FLC plans. The DECP is critical for providing coherence and supports decision-making by:

- enabling understanding of the experimentation landscape – supported by the DEMIS to enable a visualisation by theme, sponsor, objectives, time and priorities;
- reflecting directed priorities set by the DFDB;
- providing assurance that activities are aligned; and
- identifying when outputs are available for exploitation.

3.17. The DECP allows alignment with budgetary cycles and reflects Defence Experimentation priorities set within the Defence Plan. The illustrative example in Figure 3.4 portrays activities plotted across the experimentation levels, mapped against priorities, time and type of experimentation. In conjunction with the assigned leads for the priority areas, the DEWG secretariat/JFD Headquarters J7 staff manage the DECP. The DEWG maintains and develops 'the picture' of each of the Defence Experimentation themes and all key concept, capability and warfare development experimentation activities. In this way, for each of the priority areas, it is possible to examine the various 'lines of activity/operation', such as: the conceptual line; exercise activities; wargaming events; academic studies/papers; and key decision points.



CUE 20	Contested Urban Environment 2020	PFT	planned force testing
DFD	Defence Force Development	TTCP	The Technical Cooperation Program
Ex	Exercise	VCDS	Vice Chief of the Defence Staff
IOpC	Integrated Operating Concept	WG	working group

Figure 3.4 – Illustrative example of the Defence Experimentation Campaign Plan

Links with the Defence Exercise Programme

3.18. While the Defence Exercise Programme is focused on the joint force for next five years, it can be used as a tool to support Defence Experimentation. Exercise directors are therefore likely to receive requests to host Defence Experimentation activities during their events. Whilst support should be offered wherever possible, the degree of support will need to be balanced against the training objectives of the exercise. Incorporating Defence Experimentation activities within training exercises may require significant additional resources (especially the

time needed to train the participants to be competent in the new ways of operating – the treatment). This will require detailed planning, preparation, cooperation and balancing by experiment sponsors, supported by those undergoing training and those delivering the exercise.

3.19. The monthly Defence Exercise Programme Working Group (DXPWG) is the desk-level forum in which experimentation requirements can be balanced alongside training objectives for each of the relevant joint training events. This forum is best placed to assist exercise sponsors in matching their experimentation requirements (normally based on warfare, concept and/or capability development requirements) to the individual exercises. Experimentation sponsors must have a very clear understanding of what is to be 'experimented against' prior to approaching the exercise planners and thus be responsible for the conduct and oversight of the experimentation activity. Experimentation sponsors must also be cognisant that FLCs may have other essential force generation requirements to test against operational capability, thereby precluding them from enabling experimentation activity.

3.20. Exercise sponsors should also exploit the proposed Defence Experimentation activity where possible to enhance the training value of the event. For example, the data gathered through experimentation may provide exercise participants and controllers with better feedback than they might otherwise be given. Where people participating in experimentation have been directed to focus on new or emerging ideas, the additional presence of experts in the activities or equipment may provide insights as to how current processes could be improved.

Test and evaluation

3.21. Test and evaluation activities are a part of the acquisition process and core to capability development; these activities can assist as a resource to execute and instrument Defence Experimentation. The link between these activities can provide an early opportunity to understand the Force Development capabilities required/available to meet operational needs but also experiment new technology. This will enable better understanding of capability requirement decisions and, through capability

development processes and assurance activities, can provide an initial technical assessment of preferred capability choices. In addition to the links through trials, the exchange of technical data to progress capabilities will help further develop and mature ideas on emerging technologies and subsequently mature user requirements and solutions to be procured.

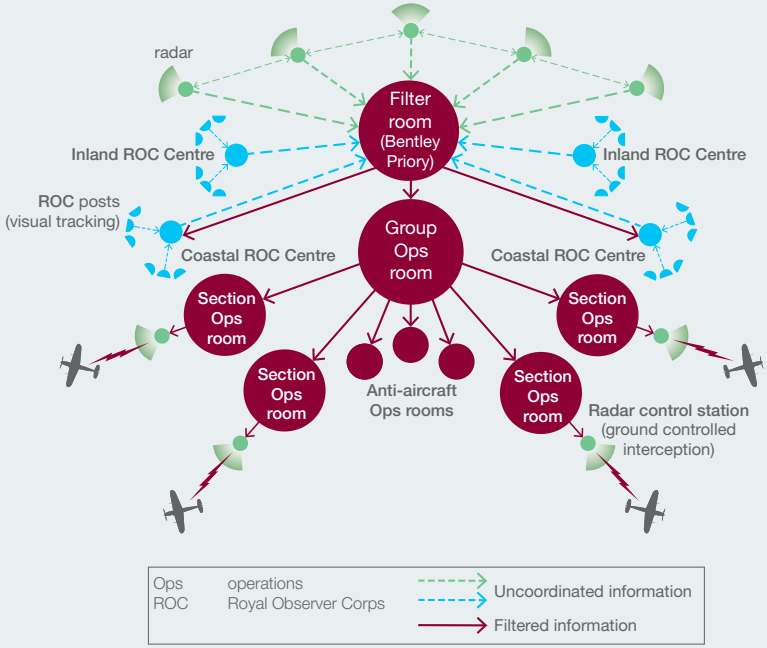
Example 3 of experimentation activities supporting Force Development: Air Chief Marshall Dowding – The evolution of the 'Dowding System', Royal Air Force Fighter Command

The Dowding System was the first integrated air defence battle management system in the world and the model upon which all others have been based. It allowed the commander to interpret the battlespace and gain an understanding of enemy movements and attack threats and manage, direct and control the battlespace and tempo. Much emergent technology was required, and it was a complex and novel fusion of information inputs, centralised command, decentralised control and resilient communication systems, allowing the Royal Air Force (RAF) to prioritise resources, gaining air supremacy over vast distances in a timely manner. The 'synthesis' of theory, emerging technology, aircraft and doctrine in the interwar years, was used to exploit the RAF Fighter Command's limited resources to maximum effect. This force development (led by Air Chief Marshall Dowding) was only possible with experimentation, supported by scientific research, pioneering new technologies, that created new doctrine for national air defence.

A complex network of coastal radar sites was critical to its success in directing and coordinating RAF fighters to intercept German Luftwaffe aircraft. Creating the first 'integrated' air defence system, took many years of commitment and effort, benefiting from scientific/technological research and doctrinal and theoretical experimentation approaches. New air bases were built, regional command centres were formed, an air observer corps provided ground verification, and a comprehensive communications network and enhanced intelligence assessment

capabilities were developed. Anti-aircraft artillery systems, barrage balloons, searchlights and acoustic detectors, created a layered defensive screen to protect vulnerable infrastructure sites. This system, overcame major technical hurdles, developing solutions that were constrained by limited funding and other competing Defence priorities in the lead up to 1939.

Together with new fighter aircraft, such as the Hurricane and Spitfire, these systems were tested and integrated into a highly responsive radar and radio command and control system, to direct fighters to intercept incoming Luftwaffe aircraft, that was critical to success in 1940.



A schematic of the Dowding System

Notes

Annex A

Defence Force Development

The scope of Defence Force Development

A.1. It is fundamental that Force Development incorporates all activities from horizon-scanning through to lessons identified on operations and exercises. Defence Force Development (DFD) is an iterative, non-linear interactive process that requires Defence to develop the capabilities of the current force and the future/conceptual force, and to assure that what is developed and delivered is compliant with our strategic direction. The DFD model seeks to set and develop the structures, processes, functions, authorities, culture and behaviours that will deliver a strategically aware, conceptually driven, resource-aligned and evidence-based approach to Force Development. The DFD process provides the linkages and connections to support: concurrent policy and conceptual developments; development of capabilities; and delivery of the joint force. It also provides the inherent flexibility to address emerging operational risks. In practical terms this equates to the following.

a. **Horizon-scanning and net assessment.** Conducts long-range assessments of possible future challenges and opportunities. This includes: trend analysis; intelligence; science and technology; diplomatic; industrial; economic; legal; moral; and ethical factors.

b. **Policy/strategy alignment.** Responsible for establishing the purpose of the force (defining the **ends**). Sets the overall, broad priorities and foci for Force Development. Through policy choices and strategy development it shapes the requirement for concept development.

c. **Concept development.** Concepts are an essential part of the mechanism to translate and develop strategic direction and propose solutions to address challenges and exploit opportunities. Concepts are developed at various levels within the DFD model, in a mutually supportive hierarchy of concepts that provides the

foundation upon which capability strategies are derived and against which near-term capability decisions are assessed. The hierarchy of concepts and associated products determines the potential ways in which we will operate and consequently shape the design of the future force and set the parameters against which our current capabilities are tested. Within the DFD model, concepts are authoritative and must be underpinned by evidence, testing and experimentation.

d. **Capability development.** This will inform capability choices based on the design of the force. These choices should be policy-compliant, threat- and resource-informed, concept-driven, pan-Defence lines of development with expertise drawn in from across Defence, and be developed in partnership with the top-level budgets. This stage will combine top-down policy imperatives, domain expertise and alliance requirements to seek out opportunities to deliver strategic advantage.

e. **Balance of investment.** Decides the force design based against operational requirements, financial and other considerations. The output is an agreed and resourced force design that directs the realisation of capabilities.

f. **Realisation of the capabilities.** The delivery of capabilities by the top-level budgets, as defined by the Defence lines of development, to performance, cost and time, and subsequent force generation, to meet the operational requirement. This is enabled by warfare development that integrates, prepares, assures and evolves the force.

g. **Operation of forces.** Informs the whole Force Development process through generating and transmitting lessons. Operations are continually served by the Force Development model, including the evolution of the force-in-being to meet new challenges and the ability to accelerate the delivery of capability in response to unforeseen, emergent eventualities.

A.2. **Evidence and assurance.** All parts of the process will be founded upon a single register of evidence that is integrated, pan-domain, readily accessible and transparent. There must be a continuous, rigorous assurance and compliance programme, which includes external validation that will validate outcomes against original intent, including checks and balances, open reporting and the acknowledgement and acceptance of failure. Internal assurance activities must continuously ensure that the designed force is compliant with strategic direction and the associated family of concepts.

A.3. **Science and technology, and innovation.** Ministry of Defence science and technology programmes, and innovation sit at the core of the Force Development process. They are critical to developing options that are then assessed through Defence Experimentation to create a credible evidence base.

A.4. **People.** The People Strategy is integral to DFD and must be considered in all parts of the DFD process; from horizon-scanning right through to operating the force. Defence People must be represented in the governance of DFD activity.

Notes

Annex B

A selection of Force Development experimentation techniques[15]

Tool/technique	Description	Positive	Negative
Literature search[16]	The review and analysis of any existing material.	Can address a wide range of topics and provide evidence quickly and cheaply if relevant previous work is available.	Relies on existing information being identified and accessible.
Empirical/ observational studies	An objectively observed practical event that does not involve the deliberate or purposeful manipulation of independent variables to establish cause-and-effect relationships. Observational studies may be used to establish associative or correlative relationships.	Low impact and ability to insert into opportunity events to collect realistic data.	Observation, especially on more qualitative aspects can be open to high degree of subjectivity.

15 Definitions derived from The Technical Cooperation Program's (TTCP's) *Guide for Understanding and Implementing Defense Experimentation* (GUIDEx) Annex B – Lexicon, and the Development, Concepts and Doctrine Centre's (DCDC's) *Wargaming Handbook*.
16 This is an experimentation technique for Defence Force Development, however, it would be a supporting approach to a formal experiment.

Tool/technique	Description	Positive	Negative
Historical analysis	The analysis of information from past operations.	Can provide robust evidence quickly if data is available. Powerful when trends correlate with results from modelling and simulation.	Sufficient data may not be easily available or may not be appropriate for the given question.
Wargaming	A war game is a process of competitive challenge and creativity, delivered in a structured and umpired/adjudicated format.[17] Can be closed or open, at any level and on any subject.	Can be applied to a wide range of problems – including those that are not well understood. Potentially quick to organise and execute. Immerses participants in the issues.	Not well suited to questions that require quantitative answers. Significant investment of participant/support staff time – limits ability to consider variations. Difficult to replicate. Difficult to validate.

17 Wargaming has a working definition of: a scenario-based warfare model in which the outcome and sequence of events affect, and are affected by, the decisions made by the players. DCDC, *Wargaming Handbook*.

Tool/technique		Description	Positive	Negative
Examples of types of war games	Seminar war game	A structured discussion between experts in several fields to elicit opinions and judgments from them, and to increase understanding. It is more structured than brainstorming (or seminars) but is not normally supported by any kind of simulation (like analytic war games).	Quick to organise and execute. Can consider a wide range of factors and can down-select or prioritise established concepts and ideas.	Can be difficult to get players to commit to specific actions. Can easily become/be mistaken for a seminar or a meeting.
	Course of action war game	A systematic planning technique for analysing, visualising and validating a plan.	Commonly used and understood method. Red cell views offer adversarial perspectives.	Need to have a plan or course of action to explore. Red and blue not treated equally: 'action-reaction-counteraction' biased in favour of blue.
	Matrix game	An open war game where players take turns to propose actions and arguments for their success.	Can be quick to organise and execute. Limited only by player imagination.	Require an experienced and knowledgeable facilitator/ adjudicator to guide the game.
	Kriegsspiel	Classic three table, closed war game with rigid adjudication (well-defined rules/models).	Limited information replicates the 'fog of war' and offers a truer test of plans.	Typically requires a lot of players and support staff. Play limited to that allowed by the rules.

Tool/technique	Description	Positive	Negative
Training exploitation	Data collection from existing field and collective training exercises.	The collection of data over time generated from multiple teams undertaking similar tasks enable baselines to be established. Real data from real events.	Difficult to control and often limited data collection as experimentation objectives are subordinate to exercise and training objectives.
Warfighting experimentation	Experimentation involving military personnel in an operational role that allows all Defence lines of development to be considered.	Outcomes related directly to operational effect.	High variability, expense and risk in terms of achieving desired outcomes – links closely to live simulation and training exploitation.

Annex C

Evidence framework

Background

C.1. The Defence Force Development (DFD) Board needs the ability to distinguish between evidence based on how rigorous the analytical process has been. Boards such as the Joint Requirements Oversight Committee and the Investment Approvals Committee make decisions based on this evidence and therefore need a mechanism to understand the reliability of the evidence and the weight they should give it in their decision-making.

C.2. There are a variety of experimentation methods and techniques that can be employed to generate evidence for Force Development. Given the breadth and complexity of Defence problems, the ideal approach may not always be available due to other constraints (for example, time, cost and resource availability). Achieving the necessary level of confidence and fidelity typically requires a series of complementary experimentation activities within an overall campaign, which cumulatively develops insights and refines understanding.

C.3. There is a risk in this approach that by using evidence for a purpose that it was not designed for, Defence could draw the wrong conclusions. Evidence is not necessarily universal and evidence generated for one purpose may not be appropriate for another, as illustrated in the following examples.

a. **Purpose of evidence.** A training exercise may provide detailed evidence regarding tactical effectiveness. However, that evidence alone may not be as appropriate to inform strategic balance of investment questions as a study specifically designed to do so.

b. **Quality versus time.** When attempting to fill gaps in the Force Development evidence base there is often a desire to prioritise speed of output over rigour of analysis. A rapid table-top exercise

on any given subject may have utility but it will not provide as rigorous evidence as a more considered programme of analysis.

C.4. Evidence needs to be communicated and considered in context. The evidence framework (shown in Figure C.1) summarises the purpose that the evidence is being used for as a testable statement. This statement is used to evaluate the efficacy of the evidence in delivering against its purpose. This approach is not about how objectively good or bad the analysis is, but rather how fit for purpose the evidence is in relation to the question being asked. Using this framework does not diminish the need for applying sound experimental design approaches; indeed, using these (or not) should be considered in evaluating evidence via the framework.

C.5. When the evidence framework has been completed it acts as a kitemark that can be applied to the initial pages of a report. However, in some cases specific elements of a report may be separately assessed if there is a significant difference in the strength of evidence supporting those elements.

Process

C.6. The approach used draws upon the Defence Science and Technology Laboratory (Dstl) Evidence Framework. Scores are produced that indicate the level of evidential support behind a product. The higher the score, the more uncertainty there is in the evidence used to draw conclusions. This is a four-stage process consisting: generating a proposition, internal assessment, external assessment, and producing a kitemark.

C.7. The intent is not to rate the quality of a particular experiment or piece of analysis but instead to inform decision-makers about the 'strength' of evidence behind specific statements so that they may weigh it appropriately in their considerations. It should be noted that a particular assessment may not relate to any particular experiment but may, for example, consist of a summary of several different experiments and analyses, and draw these together for consideration.

Generating the proposition

C.8. For the purpose of this process, a proposition is described as a proposal for consideration declared in a statement that affirms or denies something and for which evidence is testable to determine the validity of, and confidence in, the proposition. The proposition should address the following.

- What is the product? (For example, is the product being assessed a report as a whole, or is it a specific assessment in one paragraph in a report.)
- Who commissioned the product?
- What hypothesis is the evidence intended to test/what decisions is the product intended to inform?

An example proposition could be as follows: SLINGER effectiveness report – a British Army Force Development product designed to test the hypothesis that the introduction of SLINGER will improve the combat effectiveness of the battlegroup when compared to other possible alternatives for delivering effect.

C.9. Where this approach is being applied to an individual insight, conclusion or finding it may be appropriate to only formulate the proposition as a hypothesis. For example, if the level of evidence supporting a particular finding varies significantly from that of other findings in the same product.

Internal assessment

C.10. Once the evidence has been generated, the originator of the research must make an appraisal of their own work based on: comprehensiveness, relevance, challenge, quantity and veracity (as shown in Figure C.1). For each of these criteria an assessment is made resulting in a score from 1 to 4. Adding these scores and comparing the final score with the scale at the bottom of the table results in an overall categorisation of the evidence. Further guidance on scoring is available from Dstl on request.

Comprehensiveness Depth, breadth	Relevance Perspectives, assumptions	Challenge Peer review, scrutiny	Quantity Variety, track record	Veracity Relatability, saliency, causality	Profile level
Extensive coverage of key issues and uncertainties; all behaviour explainable; 'known knowns'	Extensive artefacts and multiple perspectives; changing majority of assumptions does not impact; very small inferential gap	Extensive challenge, from department, national, international perspectives; caveats and assumptions clear, no limitations on utility for purpose	Extensive methods; subjective and objective; multiple alternative lines of enquiry or best practice approach with extensive track record	Proposition highly relatable to evidence base, supportive and integrated view; all relevant alternative accounts for findings eliminated; can state factor(s) A cause outcome(s) B	1
Majority coverage of key issues and uncertainties; some key behaviour explainable; 'known unknowns'	Good artefacts and some perspectives; changing majority of assumptions has limited impact; small inferential gap	Good challenge, from wider department; caveats and assumptions clear, some limitations on utility for purpose	Good methods; subjective and objective; many alternative lines of enquiry or good practice approach with good track record	Proposition largely relatable to evidence base, supportive and integrated view; alternative accounts for findings largely eliminated; can state factor(s) A very likely to cause outcome(s) B	2
Some coverage of key issues and uncertainties; some relationships can be described; 'unknown unknowns'	Limited artefacts and perspectives; changing some assumptions significantly impacts; large inferential gap	Limited challenge, from other relevant projects; caveats and assumptions clear, large limitations on utility for purpose	Limited methods; subjective or objective; few alternative lines of enquiry or single practice approach with limited track record	Proposition somewhat relatable to evidence base, supportive and integrated; some alternative accounts for findings eliminated; can state factor(s) A may well cause outcome(s) B	3
Majority of key issues and uncertainties not covered; very difficult to explain or describe anything; 'unknowable unknowns'	Very limited artefacts and perspectives; changing majority of assumptions significantly impacts; very large inferential gap	Very limited challenge, from within project; caveats and assumptions not clear, significant limitations on utility for purpose	Very limited methods; subjective or objective; no alternative lines of enquiry or single practice approach with no track record	Proposition have little or no relation to evidence base, not supportive and integrated; few alternative accounts for findings eliminated; can state factor(s) A might cause outcome(s) B	4

For a given proposition consider each criteria in turn. Select a cell in each column that contains the statements that best describe the situation, noting that not all statements within a cell have to be relevant. Assign a score based on the profile level. Once complete add up the scores for each criteria. Compare the total score to the warrant scale to derive a warrant statement expressing the degree of belief in the quality of evidence for the proposition.

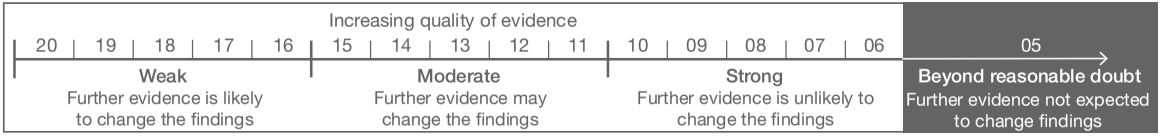


Figure C.1 – Evidence profile table for internal assessment

External assessment

C.11. An appropriately qualified assessor outside the project team must assess the validity of the evidence once it has been completed. The identity of this reviewer should be captured in relevant documentation. Identifying the external assessor is an important step in ensuring the validity of the warrant and should be planned for by the producers of the product. The validation criteria by which the external assessment is conducted uses the following: face (plausibility), criterion, construct and content (as shown in Figure C.2). A score from 1 to 4 is generated for each criterion and the sum of these scores is compared to the scale at the bottom of the table to generate an overall categorisation of the evidence. Further guidance on scoring is available from Dstl on request.

Face Plausibility of artefacts	Criterion Appropriate measurement derived from artefacts	Construct Relevance of representation of key mechanisms	Content Interpretative weight	Profile level
Highly plausible; highly relevant and familiar to recipients; highly appropriate for intended purpose; highly relatable to prior experience	Key artefacts highly suitable for intended purpose; actual artefacts used for measurement; strong alignment between things being studied and thing being proposed	Key mechanisms highly appropriate; highly adequate and sufficient for purpose; strongly aligned to current understanding of issue	High interpretive weight giving extensive insight. Comes from strong focus on relevant issues and drivers with high fidelity in findings across breadth and depth	1
Largely plausible; largely relevant and familiar to recipients; largely appropriate for intended purpose; largely relatable to prior experience	Key artefacts largely suitable for intended purpose; surrogate artefacts used for measurement, largely adequate; good alignment between things being studied and thing being proposed	Key mechanisms largely appropriate; largely adequate and sufficient for purpose; largely aligned to current understanding of issue	Good interpretive weight giving good insight. Comes from good focus on relevant issues and drivers with good fidelity in findings across breadth and depth	2
Somewhat plausible, imitations with arguments; somewhat relevant and familiar to recipients; somewhat appropriate for intended purpose; somewhat relatable to prior experience	Key artefacts somewhat suitable for intended purpose; surrogate artefacts used for measurement, somewhat adequate; limited alignment between things studied and thing being proposed	Key mechanisms somewhat appropriate, some limitations with structure; somewhat adequate and sufficient for purpose; somewhat aligned to current understanding of issue	Some interpretive weight giving limited insight. Comes from limited focus on relevant issues and drivers with limited fidelity in findings across breadth and depth	3
Largely implausible; largely irrelevant and unfamiliar to recipients; largely inappropriate for intended purpose; largely unrelatable to prior experience	Key artefacts largely unsuitable for intended purpose; surrogate artefacts used for measurement, largely inadequate; no alignment between things being measured and thing being proposed	Key mechanisms largely inappropriate, major limitations with structure; largely inadequate and insufficient for purpose; largely lack alignment to current understanding of issue	Little or no interpretive weight giving little insight. Comes from little focus on relevant issues and drivers with little fidelity in findings across breadth and depth	4

For a given proposition consider each criteria in turn. Select a cell in each column that contains the statements that best describe the situation, noting that not all statements within a cell have to be relevant. Assign a score based on the profile level. Once complete add the scores for each criteria. Compare the total score to the validity scale to derive a validity statement expressing the degree of belief in the validity of the proposition being made.

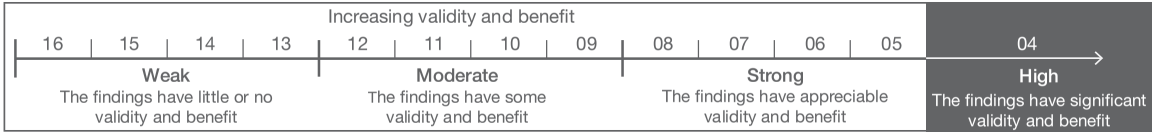


Figure C.2 – Validation table for external assessment

Producing the kitemark

C.12. A summary of the proposition, internal assessment and external assessment is produced. An example of a kitemark is shown at Figure C.3, though the precise form is subject to alteration depending upon the nature of the product. The internal and external assessment ratings should be reported by their categories, for example, 'strong' rather than the specific scores (although these should be documented separately). It is often worth recording the reasons for selecting particular scores separately as part of the evidence trail. It should be noted that not all decisions will require the strongest level of evidence, as pragmatism around resource and time issues may need to be exercised. In these cases the tables can be helpful in suggesting the sorts of steps that may be required to reduce uncertainty in future.

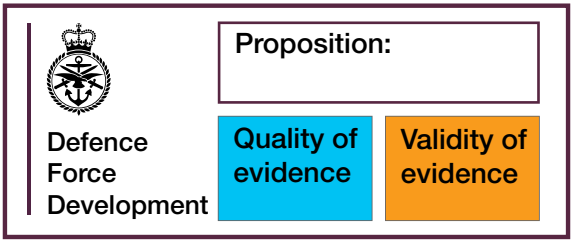


Figure C.3 – An example kitemark

Notes

Annex D

Further reading and information

Select reference publications and bibliography

Defence Force Development Handbook

Overview of the Defence Experimentation Management Information System

Development, Concepts and Doctrine Centre (DCDC), *Wargaming Handbook*

DCDC, *Red Teaming Guide,* (2nd Edition)

The Defence Operating Model

The British Army, *Experimentation Handbook Part A: Introduction to Experimentation*

Land Handbook, *Force Development Analysis and Experimentation,* (2014)

Joint Service Publication (JSP) 507, *Investment Appraisal and Evaluation*

JSP 536, *Governance of Research Involving Human Participants*

JSP 655, *Defence Investment Approvals*

JSP 939, *Defence Policy for Modelling and Simulation*

HM Treasury, *The Aqua Book - Guidance on producing quality analysis for government*

The Technical Cooperation Program (TTCP), *Guide for Understanding and Implementing Defense Experimentation (GUIDEx)*

DEFD Handbook (Version 2)

United States (US) Department of Defense (DoD), Information Age Transformation Series Command and Control Research Program (CCRP), *The Code of Best Practice: Experimentation*

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Richard A Kass, *The Logic of Warfighting Experiments*, (2006)

US DoD, CCRP, *NATO Code of Best Practice for C2 Assessment*, (2002)

North Atlantic Treaty Organization (NATO), *Concept Development and Experimentation Handbook*

Points of contact

Defence Experimentation Working Group: UKStratCom JFD DFD SO1A

Defence Experimentation Management Information System enquiries and feedback: UKStratCom JFD DFD SO1A

Integrated Warrior: DCDC-IntegratedWarrior@mod.gov.uk

Lexicon

Section 1 – Acronyms and abbreviations

CAPDEV	capability development
CONDEV	concept development
DECP	Defence Experimentation Campaign Plan
DEP	Defence Experimentation Pathway
DEMIS	Defence Experimentation Management Information System
DEWG	Defence Experimentation Working Group
DFD	Defence Force Development
DFDB	Defence Force Development Board
Dstl	Defence Science and Technology Laboratory
DTIB	Defence Technology and Innovation Board
DXPWG	Defence Exercise Programme Working Group
FLC	front line command
JFD	Joint Force Development
JSP	joint Service publication
MOD	Ministry of Defence
NATO	North Atlantic Treaty Organization
OPRG	Operational and Policy Requirements Group
PFT	planned force testing
SJFHQ	Standing Joint Force Headquarters
TTCP	The Technical Cooperation Program
UCR	urgent capability requirement
US	United States
WARDEV	warfare development

Section 2 – Terms and definitions

This section provides a list of unendorsed definitions[18] that may be helpful to the reader.

capability development
The translation of operating, domain, functional and thematic concepts, in line with Defence Strategic Direction and the Defence Plan, to develop and deliver military capability. The process assesses and bridges the gap between existing and future capabilities. Capability options are presented for balance of investment decision-making and result in the force design. (Defence Operating Model, 2019)

concept development
The application of a deliberate methodology to explore, understand and define Defence problems, determine possible solutions that guide how forces will operate and influence the policies and capabilities that are required to enable the force to achieve success. (DFD Blue Print, 2019)

Defence Experimentation
Controlled and directed activities designed to discover new information about an idea or concept, test a hypothesis or validate a solution or choice in support of Force Development. (DFDB, October 2019)

Defence Experimentation Pathway
The mechanism to capture, support and cohere Defence Experimentation activity connected to prioritised Defence Force Development activity.

Defence Force Development
An evidence-informed process by which forces, and capabilities are designed, tested and generated to meet policy requirements effectively and efficiently. (Defence Operating Model, 2019)

18 Whilst these terms have been accepted by the Force Development community and published in the quoted sources, they still need to be ratified through the UK joint terminology process.

development experimentation
Designed to assist in the development of an idea, concept or capability, to mature it to a point where it can be validated. It is a refining process designed to test, at an early stage, whether the idea, concept or capability will deliver against its expectations. (DFDB, October 2019)

discovery experimentation
Designed to build understanding, to inform the development of potential solutions, to introduce novel ideas, concepts and capabilities in the early stages and to help refine the question to be addressed. This type of experiment should be conducted against a broad hypothesis to ensure it has the freedom to explore but bounded for it to be achievable.
(DFDB, October 2019)

force exploration
The application of innovative thinking to the use of emerging and disruptive technology, innovative ideas, and novel ways of operating to understand how they may be employed on operations or in delivering Defence business, together with an assessment of feasibility.
(Derived from *MOD Finance Military Capability Strategic Force Development*, November 2015)

force variation testing
Testing variations of the planned force baseline to provide evidence of the efficacy of specific capabilities, concepts or policy to achieve operational advantage to the future force.
(*Strategic Force Development Committee and Working Group Terms of Reference*, May 2020)

planned force testing
Testing of the current planned force against a series of policy compliant scenarios which represent current Defence Planning Assumptions (including concurrency), to provide an evidence base to support capability and Force Development.
(Derived from *MOD Finance Military Capability Strategic Force Development*, November 2015)

validation experimentation
Designed to test, as far as practicable, the effectiveness of a given idea, concept or capability such that it may be considered viable enough to inform Force Development decisions. (DFDB, October 2019)

warfare development
The synthesis of operational analysis and lessons identified through the observation of operations, training and exercises; doctrinal and technological developments, and capability integration and experimentation across all military operating domains.
(DFD Blue Print, 2019)

Section 3 – A comparison of key UK and United States Force Development terms

Term	UK	United States
Force development	**Defence Force Development** An evidence-informed process by which forces, and capabilities are designed, tested and generated to meet policy requirements effectively and efficiently. (*Defence Operating Model*, 2019)	**Joint Force Development** Provides a structured mechanism for adapting and applying current functions, capabilities, and concepts to improve and evolve the strength, agility, endurance, resilience, flexibility, interoperability, and awareness of the current force to improve operational readiness and effectiveness, generally within a 2-7 year time frame. (Chairman of the Joint Chiefs of Staff Instruction 3030.01, 3 December 2019)
Force design	**force design** The process by which evidence provided by the force-exploration process is translated into costed options for the future force structure and capability to support the proposed future policy posture and Defence Planning Assumption options, within a projected budget. (*Finance Military Capability Operating Model*, 2020)	**Joint Force Design** The Joint Force constantly innovates to discover new ways of operating and integrating revolutionary capabilities that maintain and expand our competitive space against potential adversaries, generally 5-15 years into the future. Force Design enables the Joint Force to adapt to future challenges through experimentation, prototyping, and other applications of technologically advanced methodologies and materiel. (Chairman of the Joint Chiefs of Staff Instruction 3030.01, 3 December 2019)

Term	UK	United States
Force structure	force structure The organisational definition of the current state of the funded force that has been generated to meet current levels of ambition and requirements defined within Defence Strategic Direction and the associated Defence Planning Assumptions. (Proposed from *Defence Force Development Blue Print*)	Force Structure The composition of DoD organizations that comprise and support US Defense forces as specified in the current National Defense Authorization Act (NDAA) and defines the organizational hierarchy through which leadership authority is exercised. This includes military end strength, military equipment procured by programs, and DoD civilian personnel to execute programs as funded by the current and applicable previous years NDAAs, and as organized under the Services' responsibilities. (DoDM 8260.03-V2, 14 June 2011)
Experimentation	Defence Experimentation Controlled and directed activities designed to discover new information about an idea or concept, test a hypothesis or validate a solution or choice. (Defence Force Development Board, October 2019)	

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